



US006341393B1

(12) **United States Patent**  
**Votel**

(10) **Patent No.:** **US 6,341,393 B1**  
(45) **Date of Patent:** **Jan. 29, 2002**

- (54) **PATIENT TRANSFER AND REPOSITIONING SYSTEM**
- (75) Inventor: **Thomas W. Votel**, Saint Paul, MN (US)
- (73) Assignee: **Ergodyne Corporation**, Saint Paul, MN (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

2,761,153 A	9/1956	Mew	5/197
2,826,766 A	3/1958	Stoner	5/498
2,827,642 A	3/1958	Huff	5/88.1
2,835,902 A *	5/1958	Fash	5/81.1 T
2,959,792 A	11/1960	Haugard	5/658
3,013,919 A	12/1961	Bialy	428/125
3,167,789 A	2/1965	Wicks	5/81.1 HS
3,284,816 A *	11/1966	Laubsch	5/81.1 T

(List continued on next page.)

**FOREIGN PATENT DOCUMENTS**

AU	8094	*	7/1933	5/89.1
CA	866094	*	3/1971	5/502
CA	1266449	*	3/1990	5/81.1 T
EP	192265	*	8/1986	5/484
FR	2567749	*	1/1986	5/484
GB	654540	*	6/1951	5/502
GB	2023010	*	12/1979	5/81.1 T
GB	2189993	*	11/1987	5/484
GB	2139487 A		11/1994	
WO	WO 95/21600		8/1995	

*Primary Examiner*—Lynne H. Browne  
*Assistant Examiner*—Robert G. Santos  
 (74) *Attorney, Agent, or Firm*—Patterson, Thuente, Skaar & Christensen, PA

- (21) Appl. No.: **09/174,110**
- (22) Filed: **Oct. 17, 1998**

**Related U.S. Application Data**

- (63) Continuation-in-part of application No. 09/057,139, filed on Apr. 8, 1998, which is a continuation-in-part of application No. 08/713,412, filed on Sep. 13, 1996, now Pat. No. 5,890,238, which is a continuation-in-part of application No. 08/527,519, filed on Sep. 13, 1995, now Pat. No. 5,737,781.
- (60) Provisional application No. 60/043,208, filed on Apr. 8, 1997, provisional application No. 60/084,519, filed on May 7, 1998, provisional application No. 60/092,286, filed on Jul. 10, 1998, and provisional application No. 60/092,287, filed on Jul. 10, 1998.
- (51) **Int. Cl.<sup>7</sup>** ..... **A61G 7/10; A47G 9/02**
- (52) **U.S. Cl.** ..... **5/81.1 T; 5/81.1 HS; 5/89.1; 5/484; 5/502**
- (58) **Field of Search** ..... **5/81.1 R, 88.1, 5/89.1, 81.1 T, 81.1 C, 81.1 HS, 502, 424, 487, 484**

(57) **ABSTRACT**

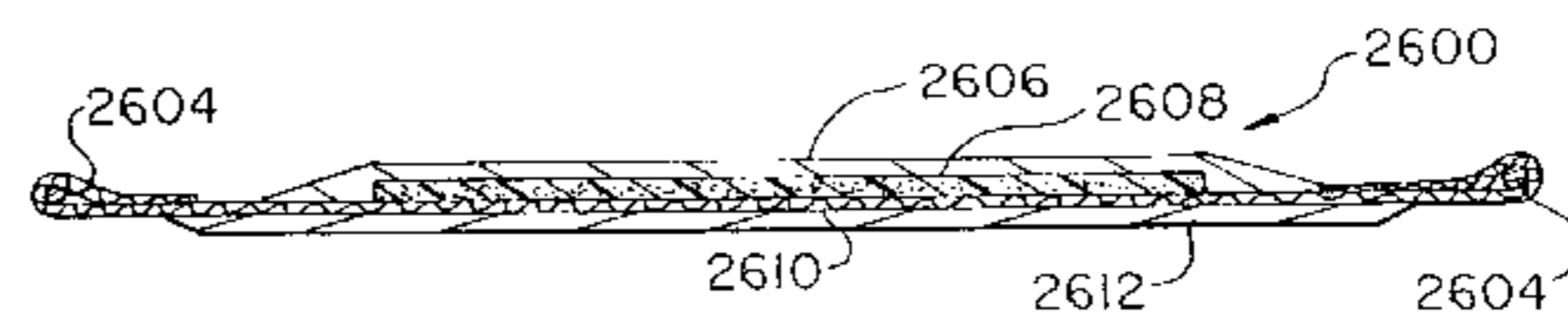
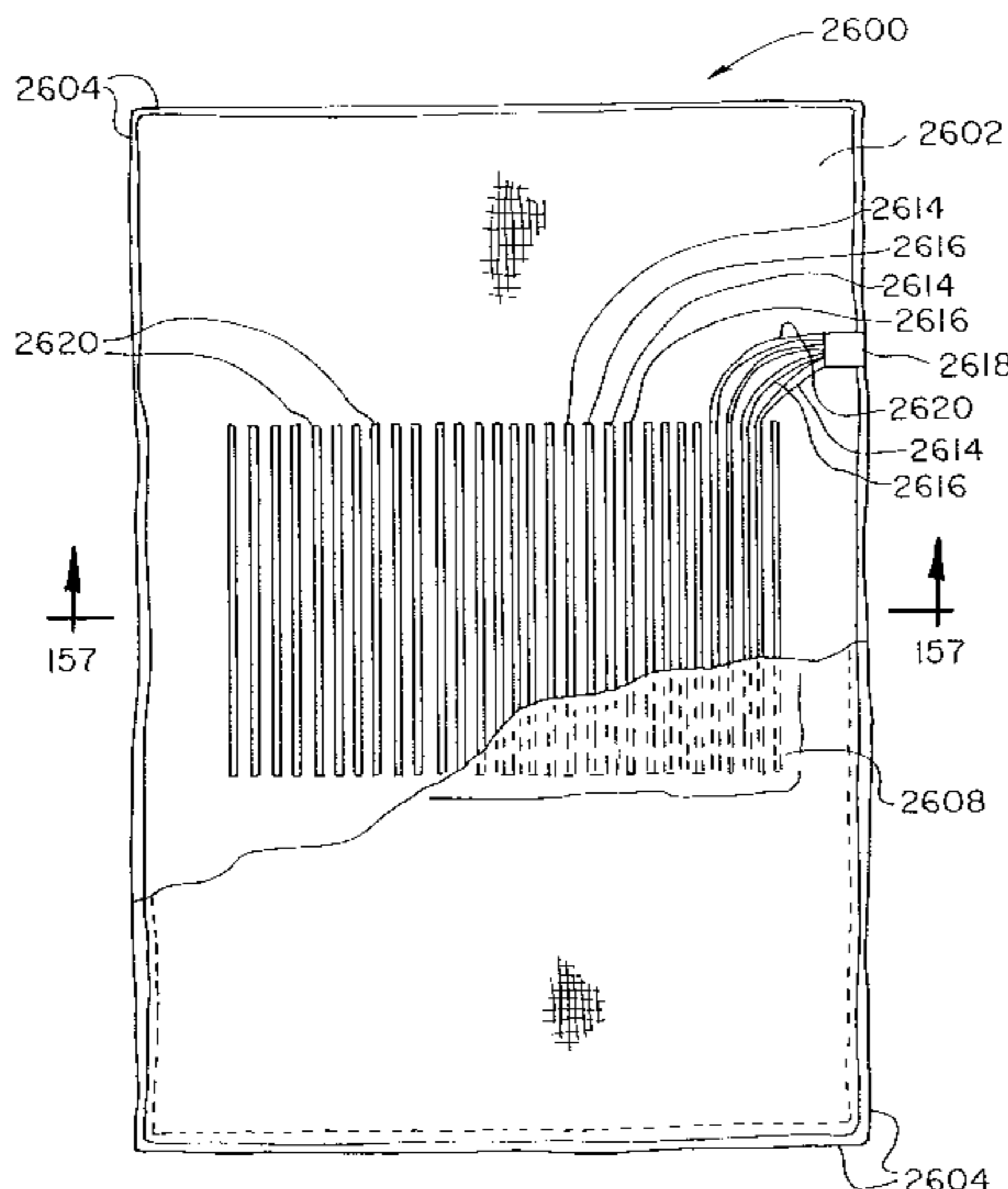
Apparatus including a substantially pliable underlayment, connecting member, and means to exert a force to transfer or reposition a patient is provided. The substantially pliable underlayment includes a substantially smooth mantle, an attaching structure operably adjacent the mantle, and a reinforcing structure for imparting resistance to mantle distortion during transfer or repositioning. The attaching structure includes a reinforced beaded edge and an attaching structure cooperating with the mantle to form a pocket accommodating a transfer bar. The reinforcing structure includes stitching disposed generally diagonally in the mantle and reinforcing fibers present in the material of the mantle. A method of using the pliable underlayment to transfer or reposition a patient is also provided.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

545,741 A	*	9/1895	Shutters	5/88.1
1,085,879 A	*	2/1914	Skeffington	5/88.1
1,334,901 A		3/1920	Higdon	5/81.1 T
1,487,150 A	*	3/1924	Deakins	5/88.1
2,015,391 A	*	9/1935	Anderson	5/627
2,135,779 A	*	11/1938	Zayotti et al.	5/627
2,350,595 A	*	6/1944	Divine	5/88.1

**49 Claims, 62 Drawing Sheets**



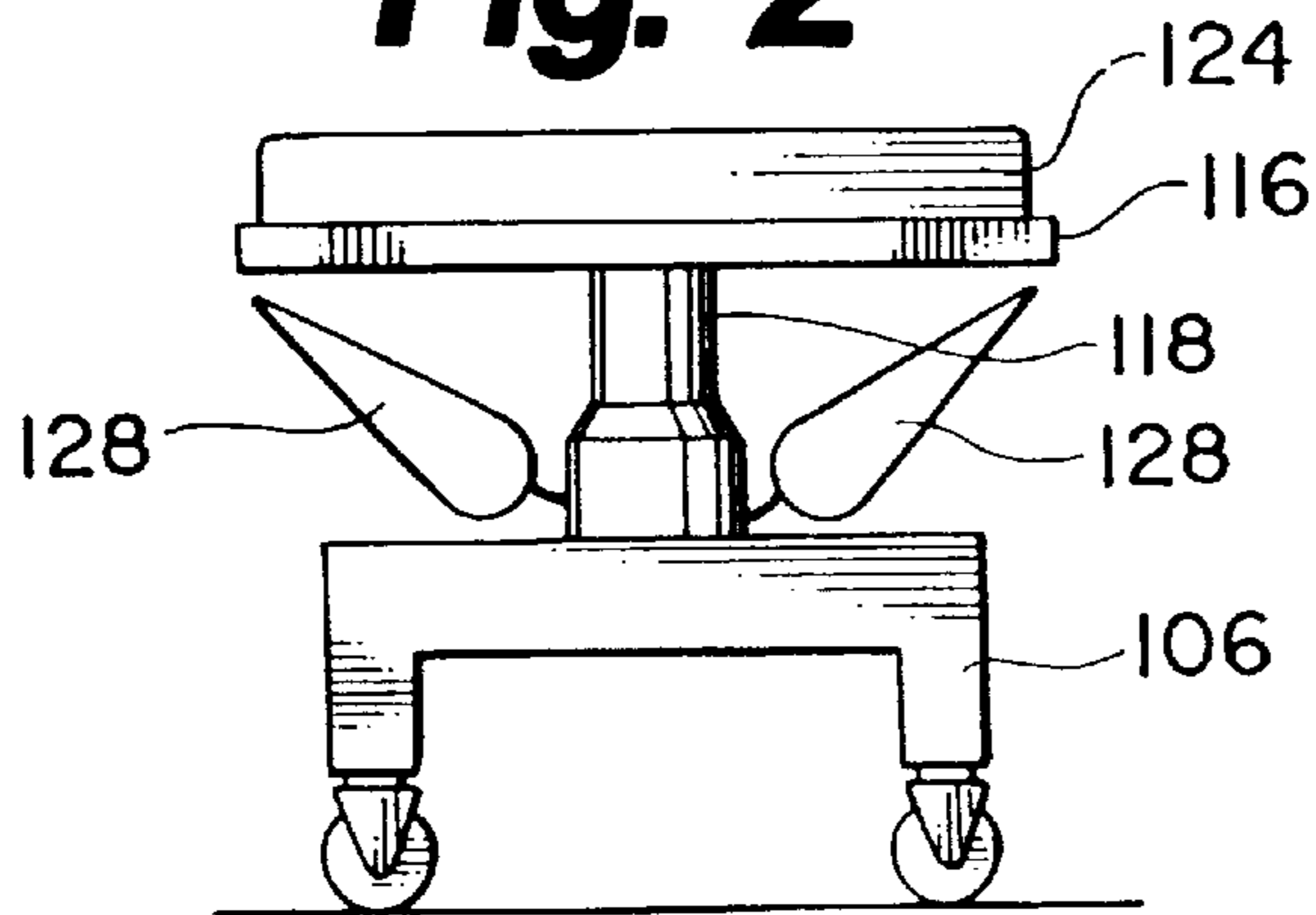




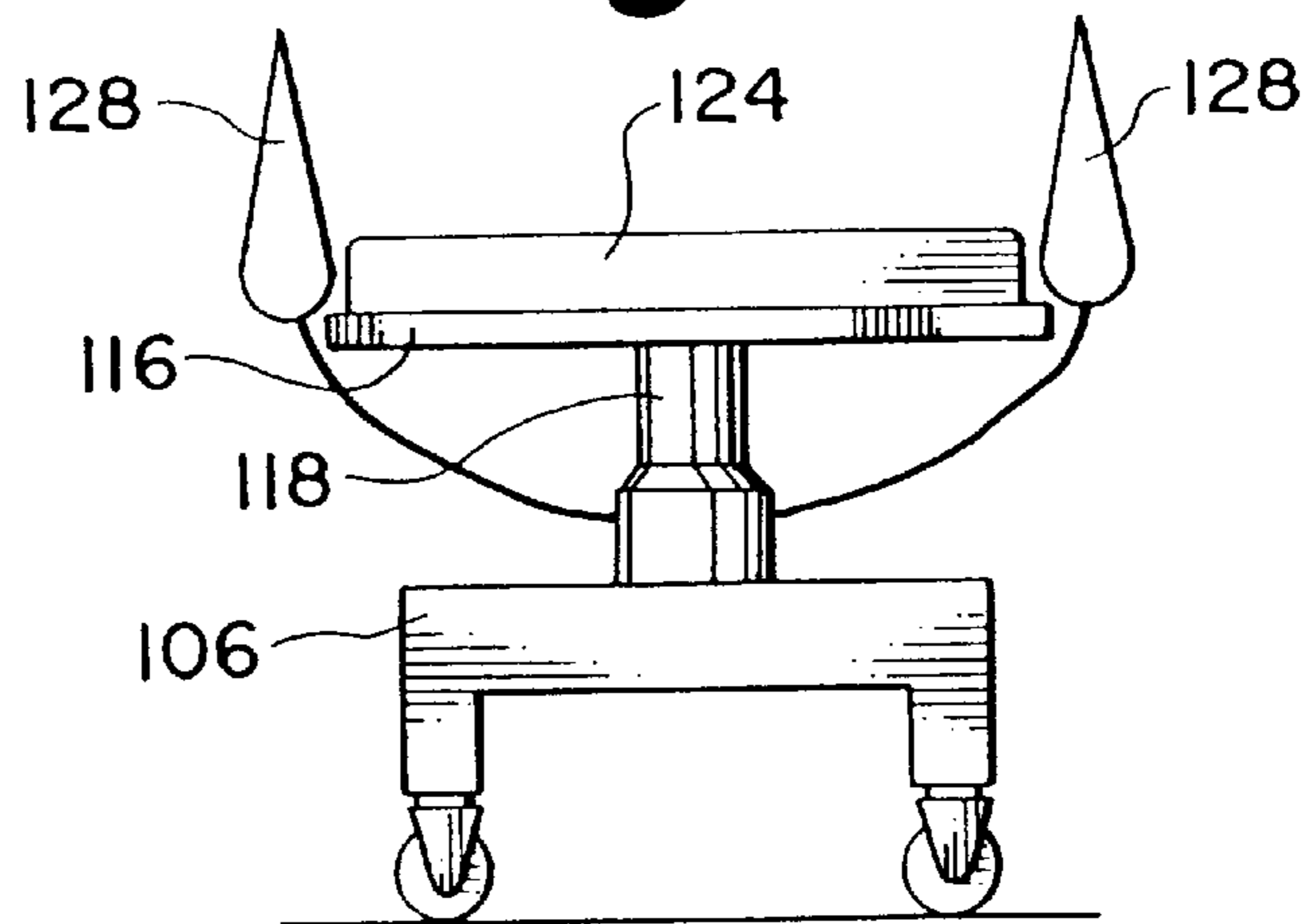




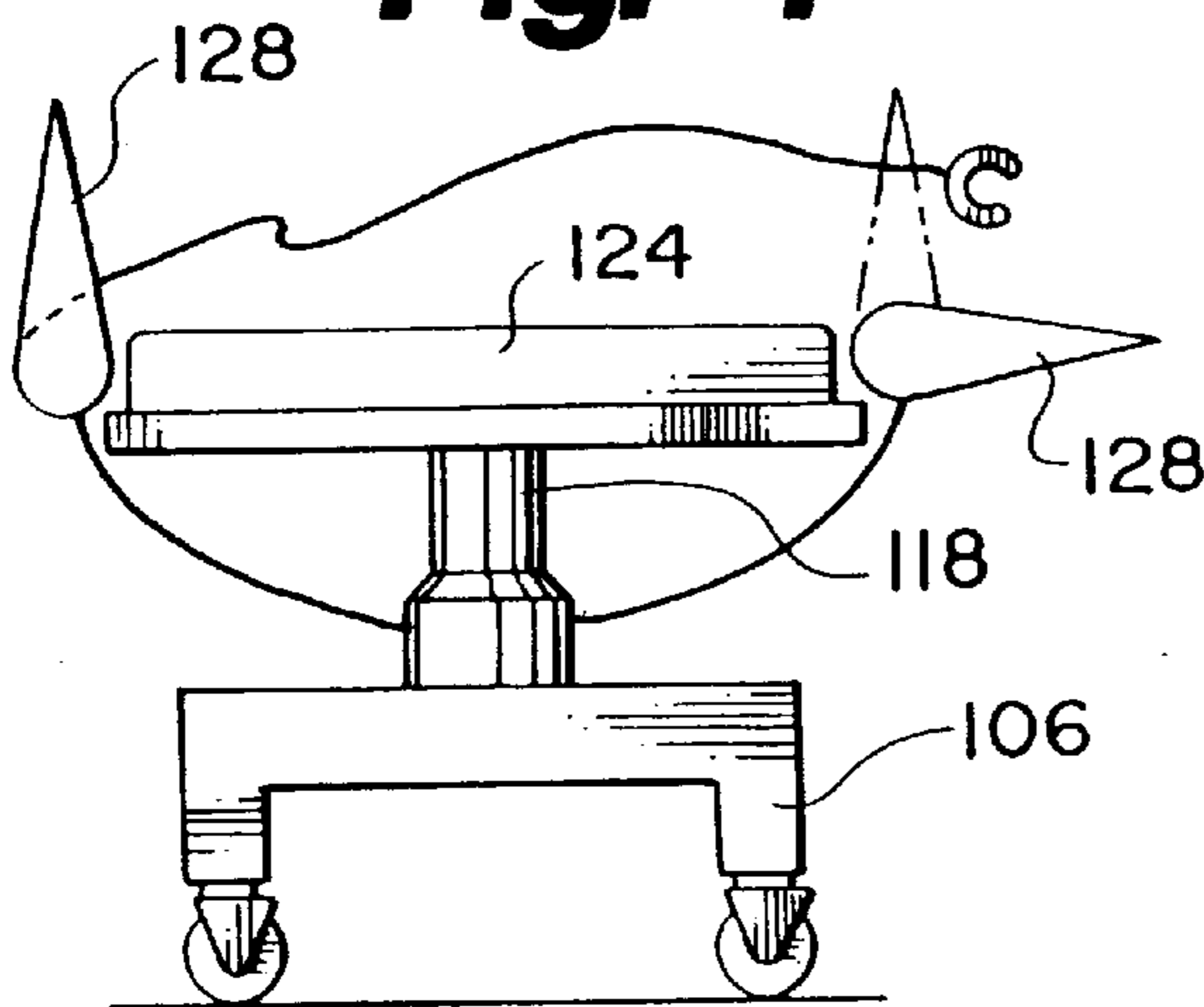
**Fig. 2**



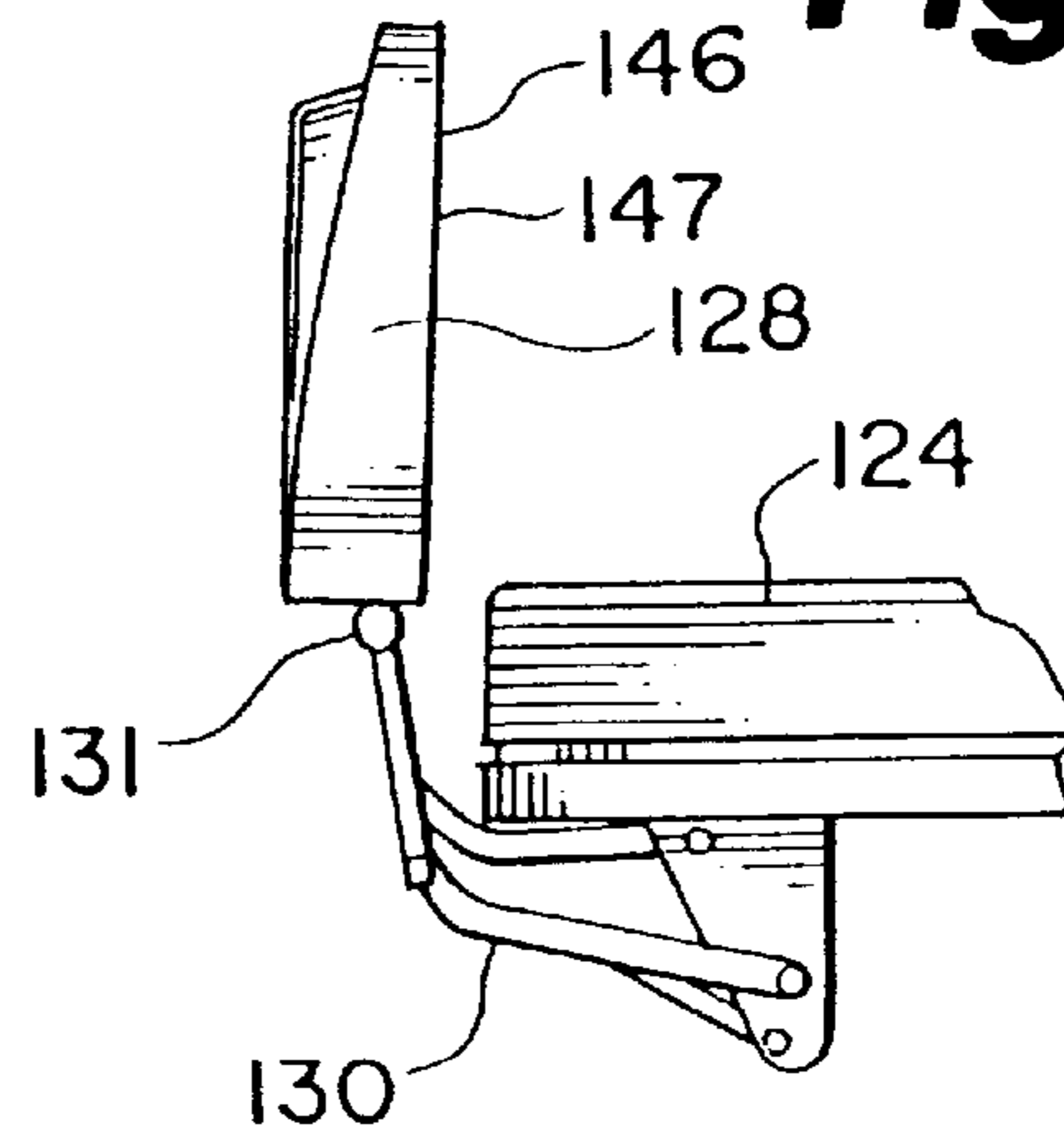
**Fig. 3**



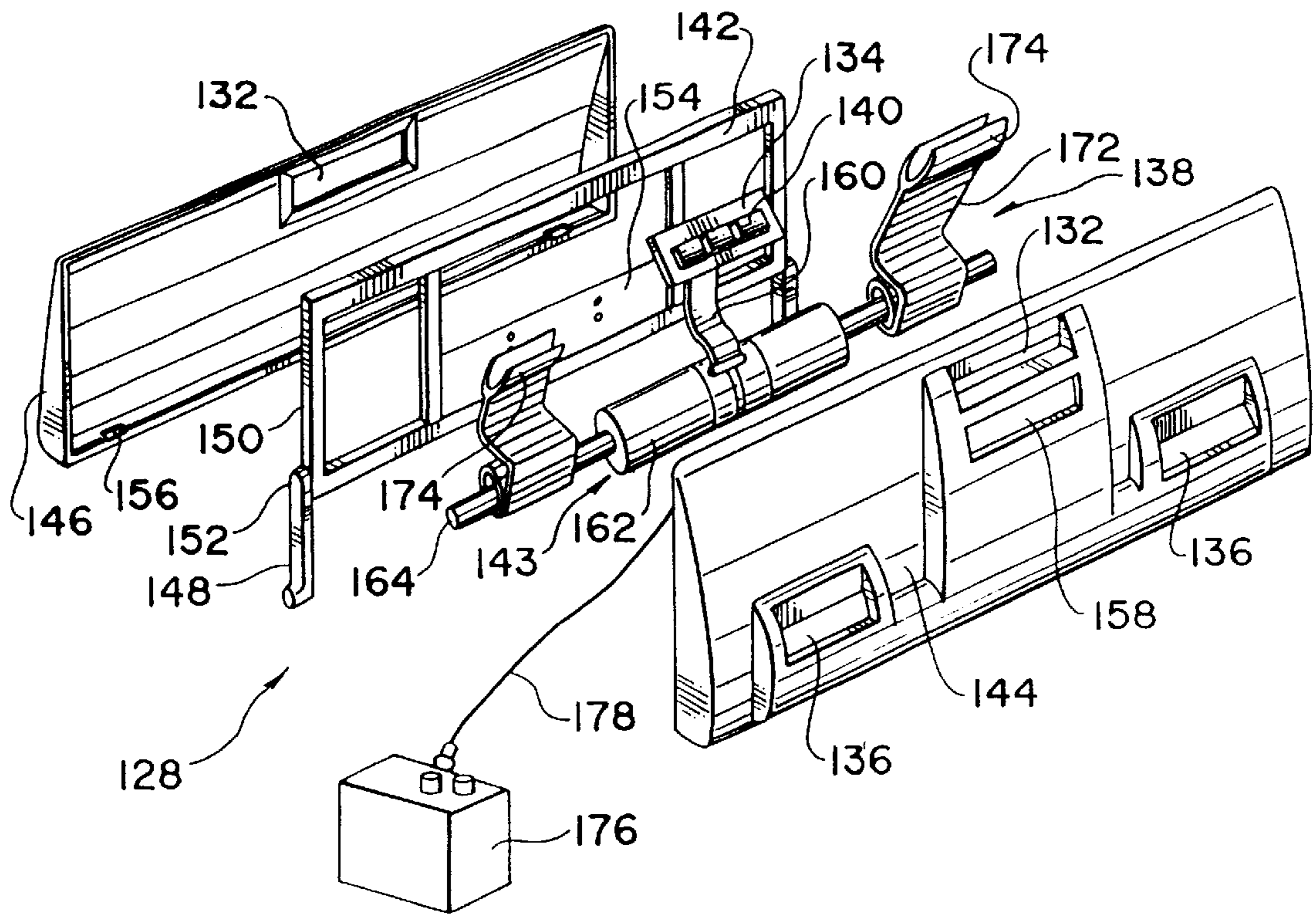
**Fig. 4**



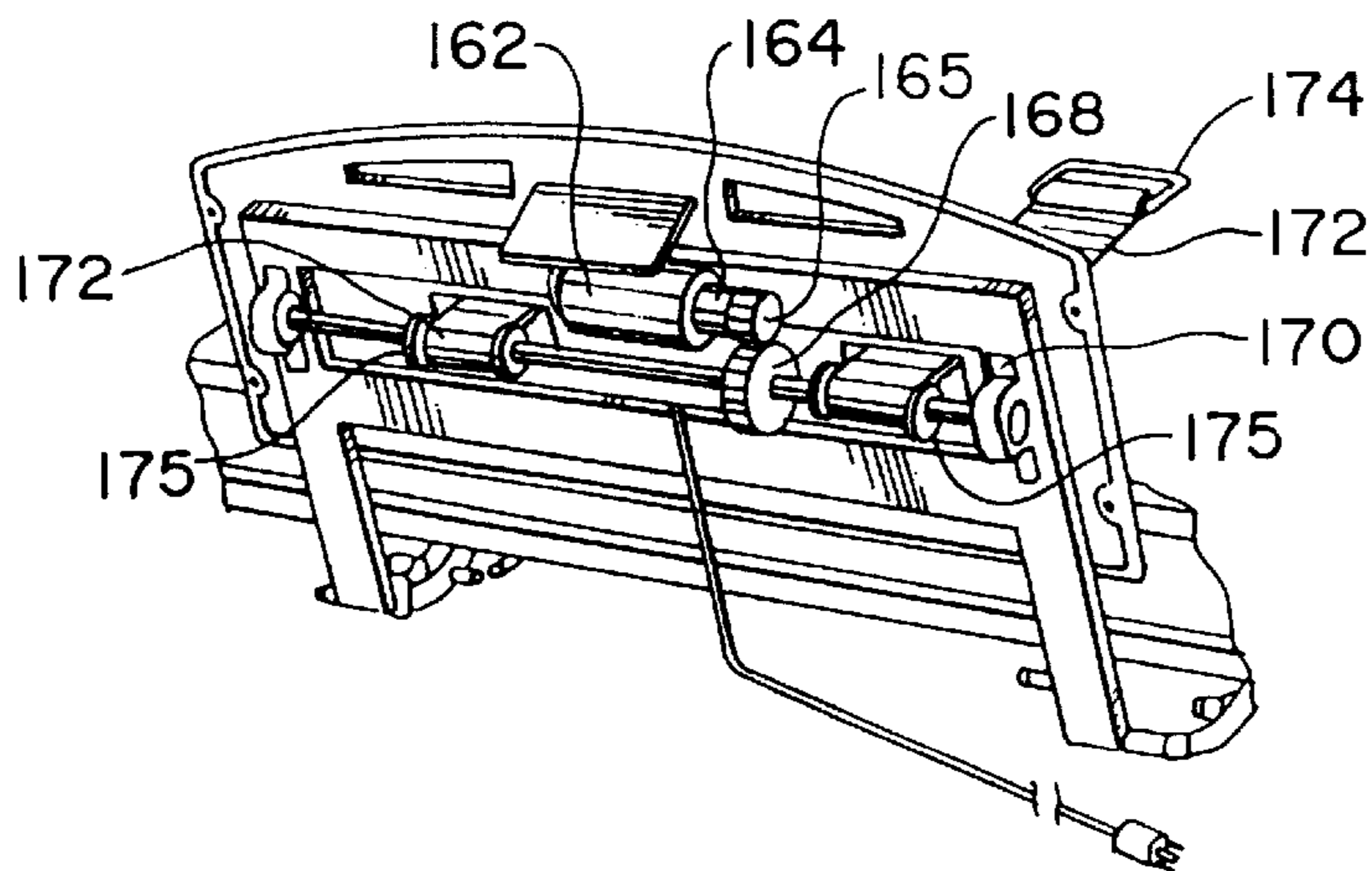
**Fig. 5**



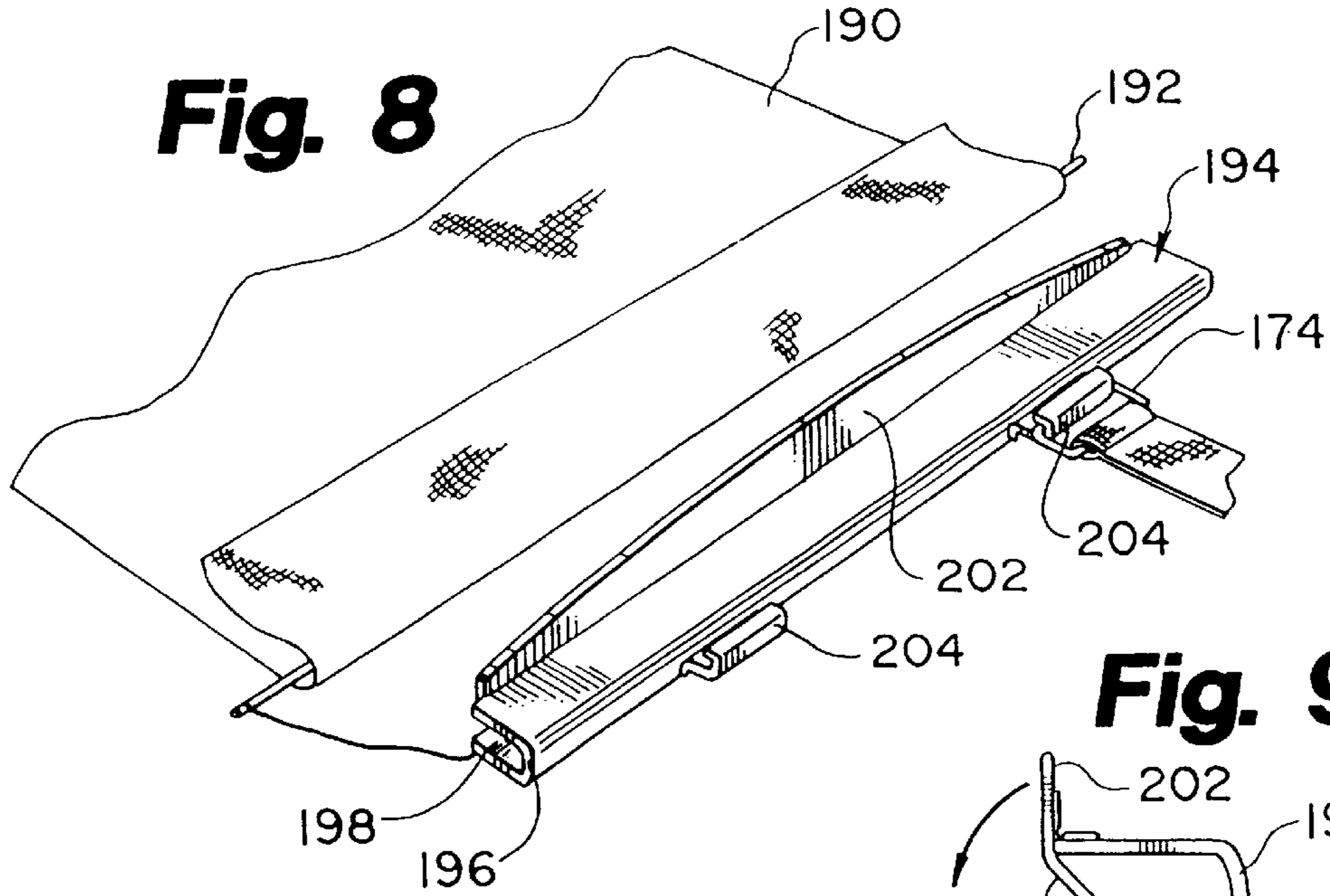
**Fig. 6**



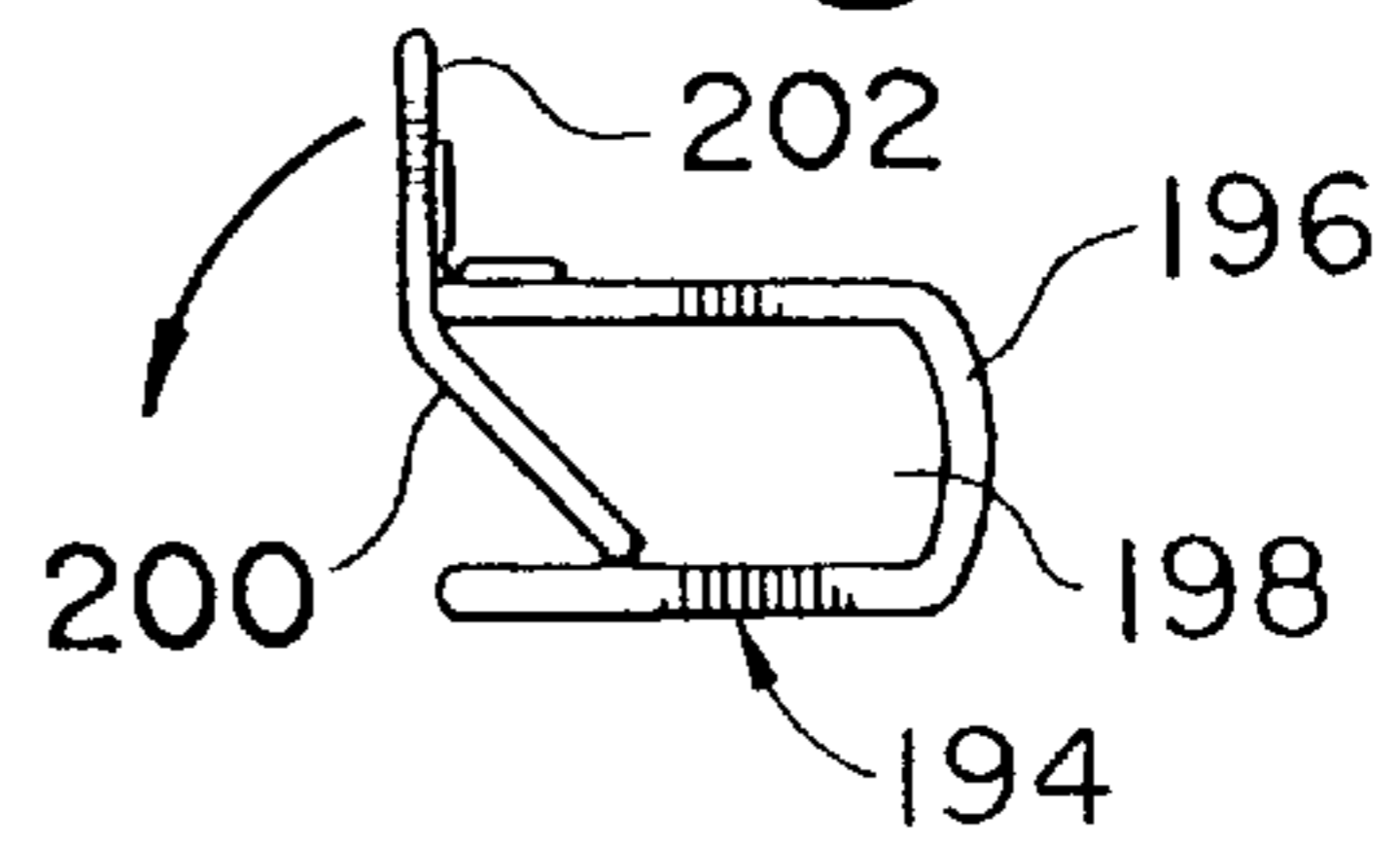
**Fig. 7**



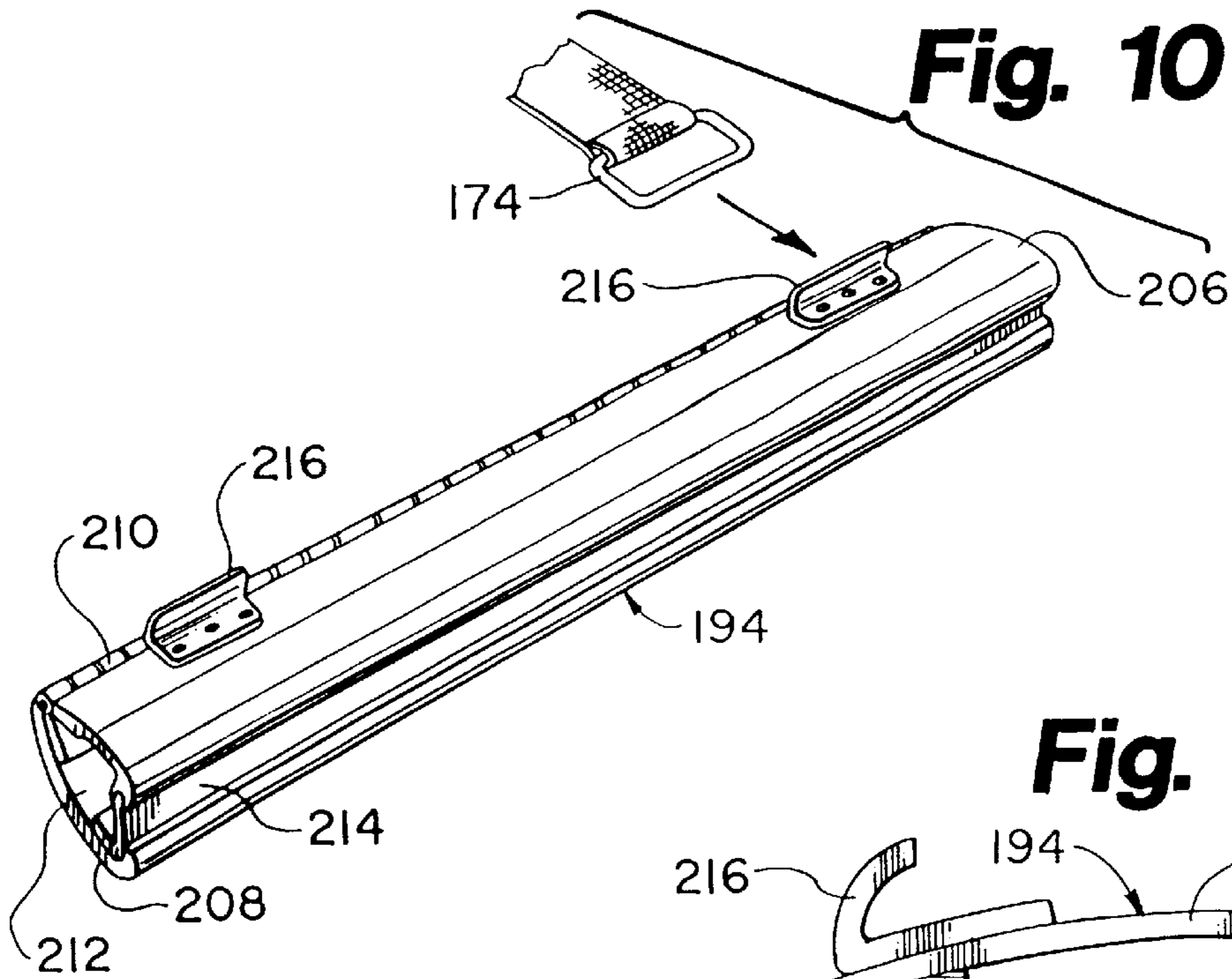
**Fig. 8**



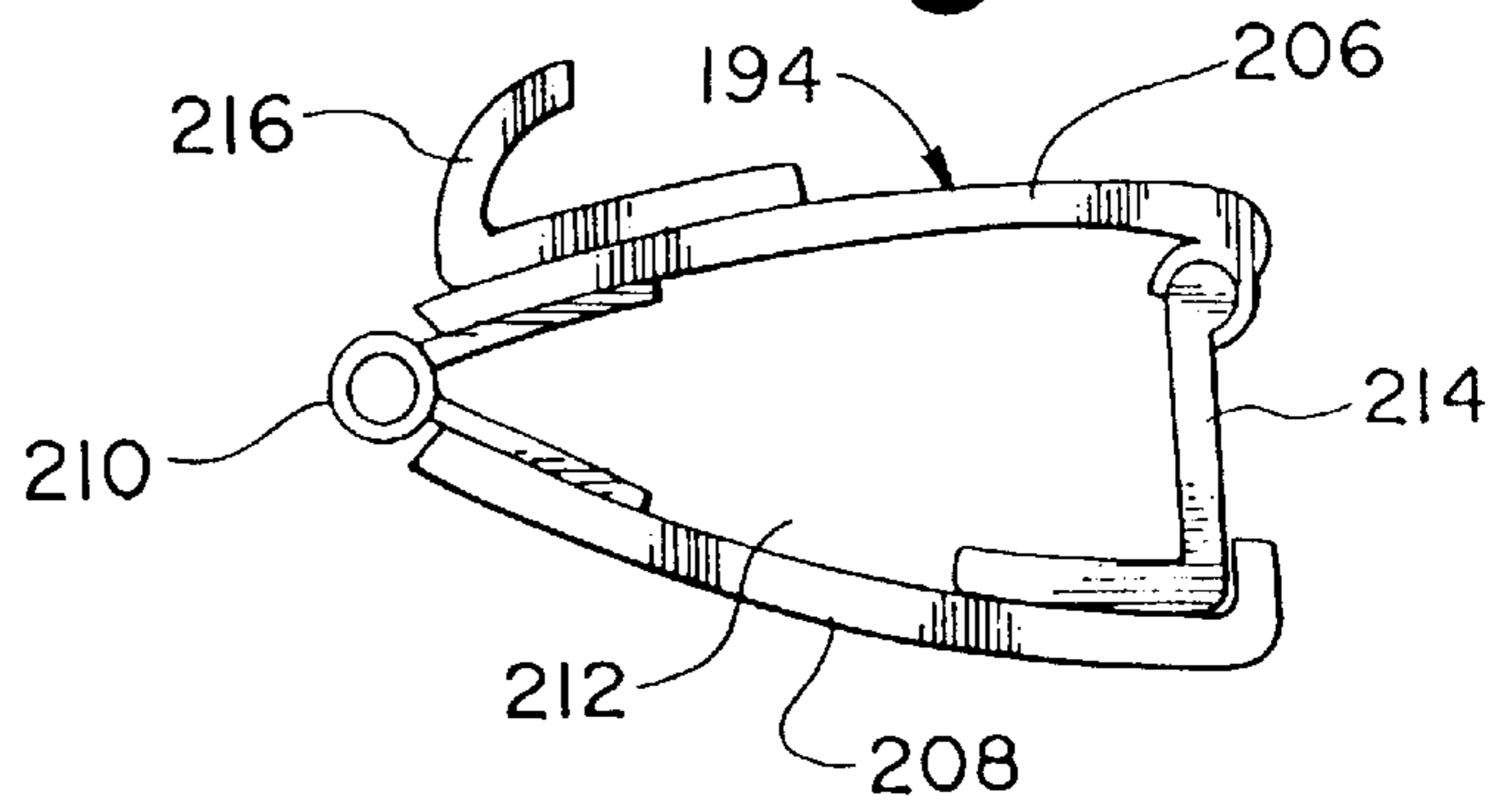
**Fig. 9**



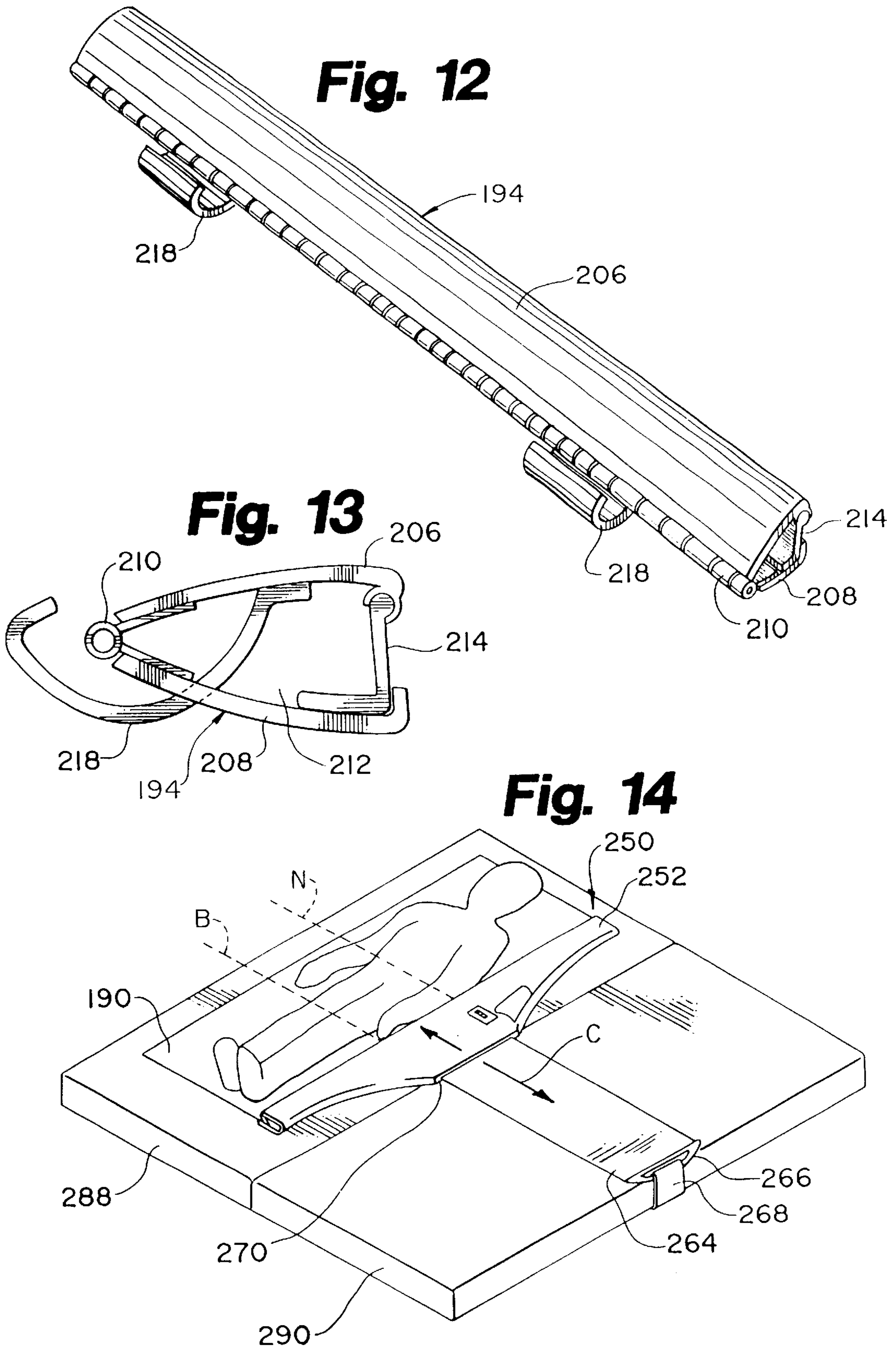
**Fig. 10**



**Fig. 11**

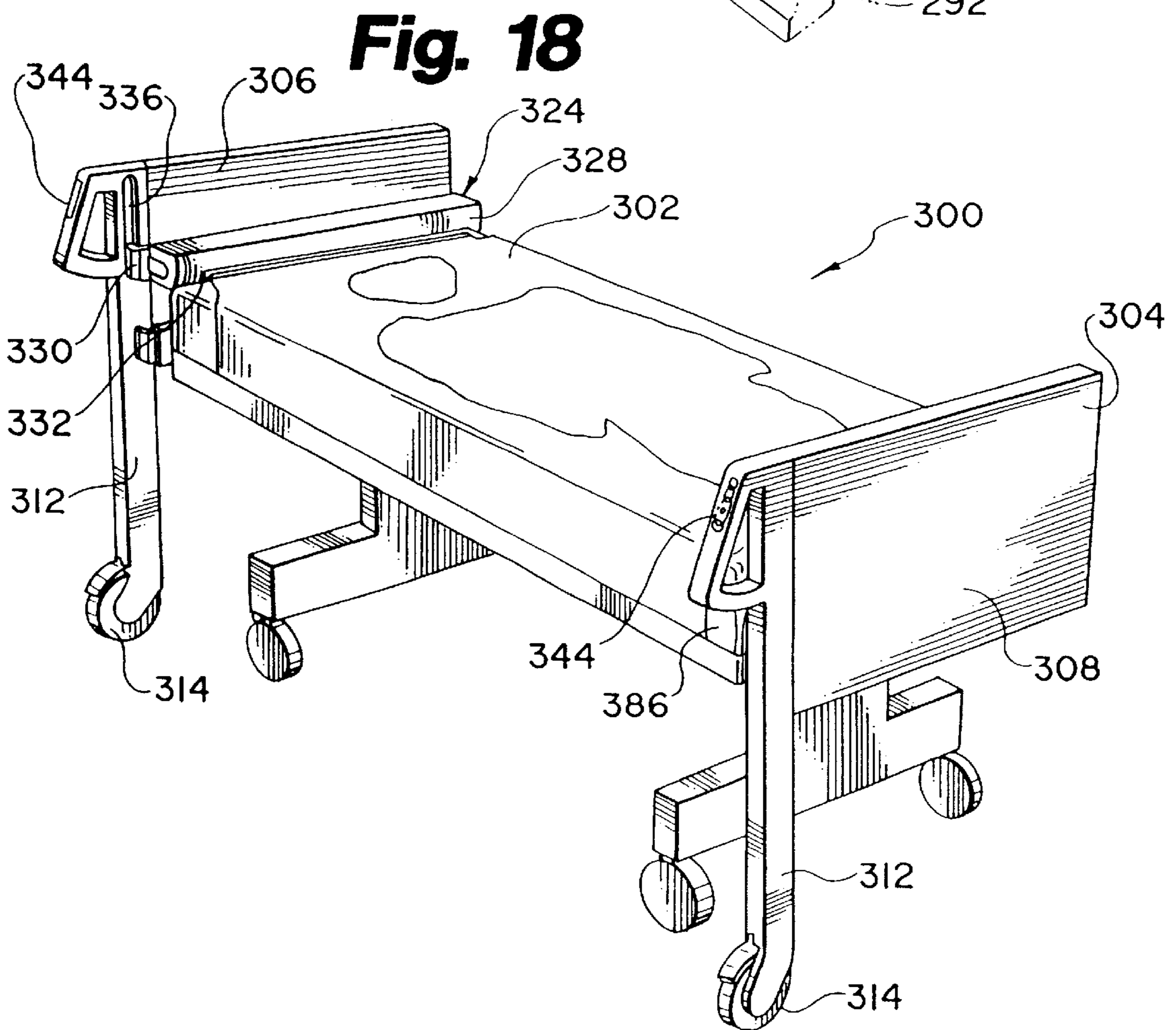
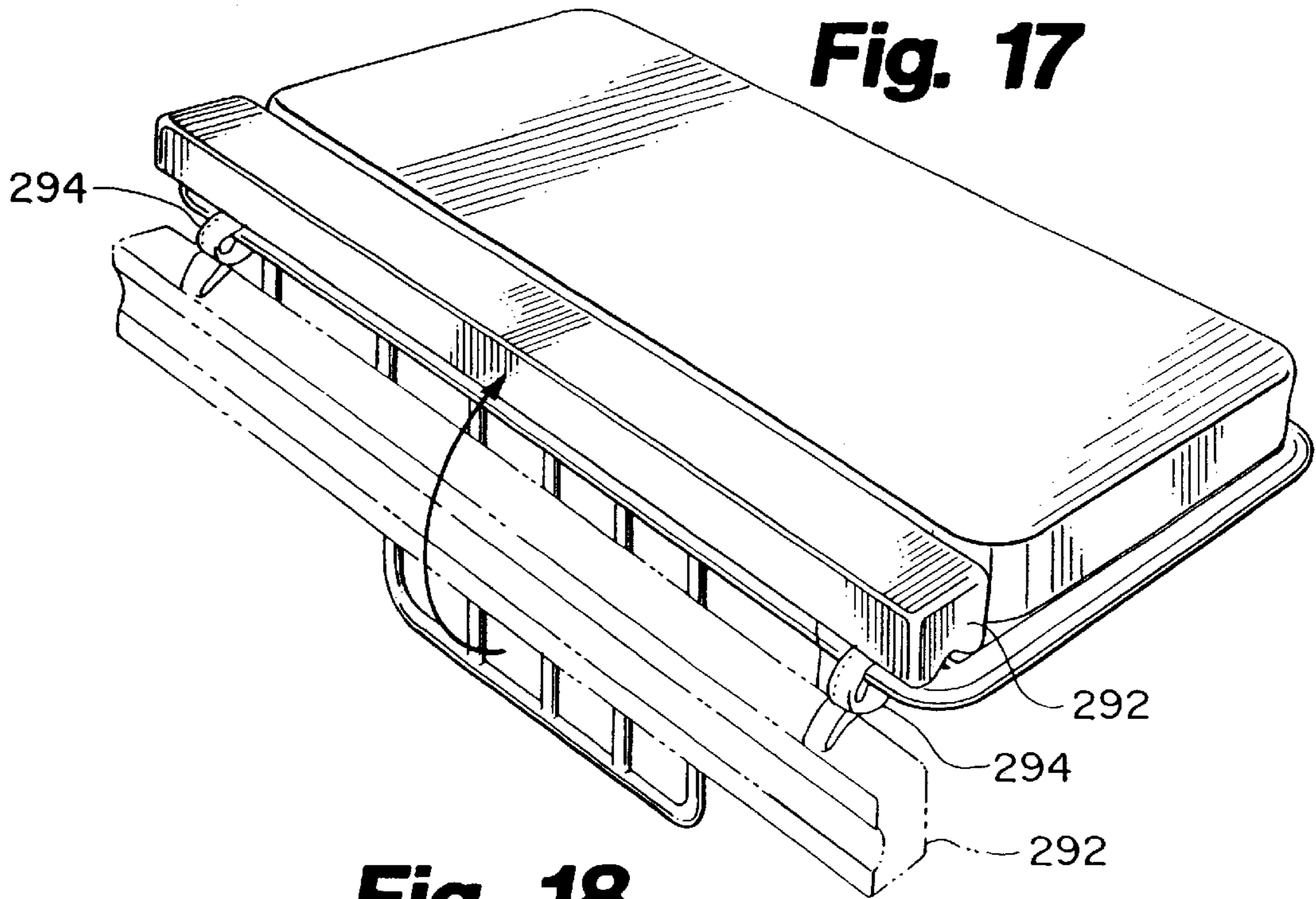




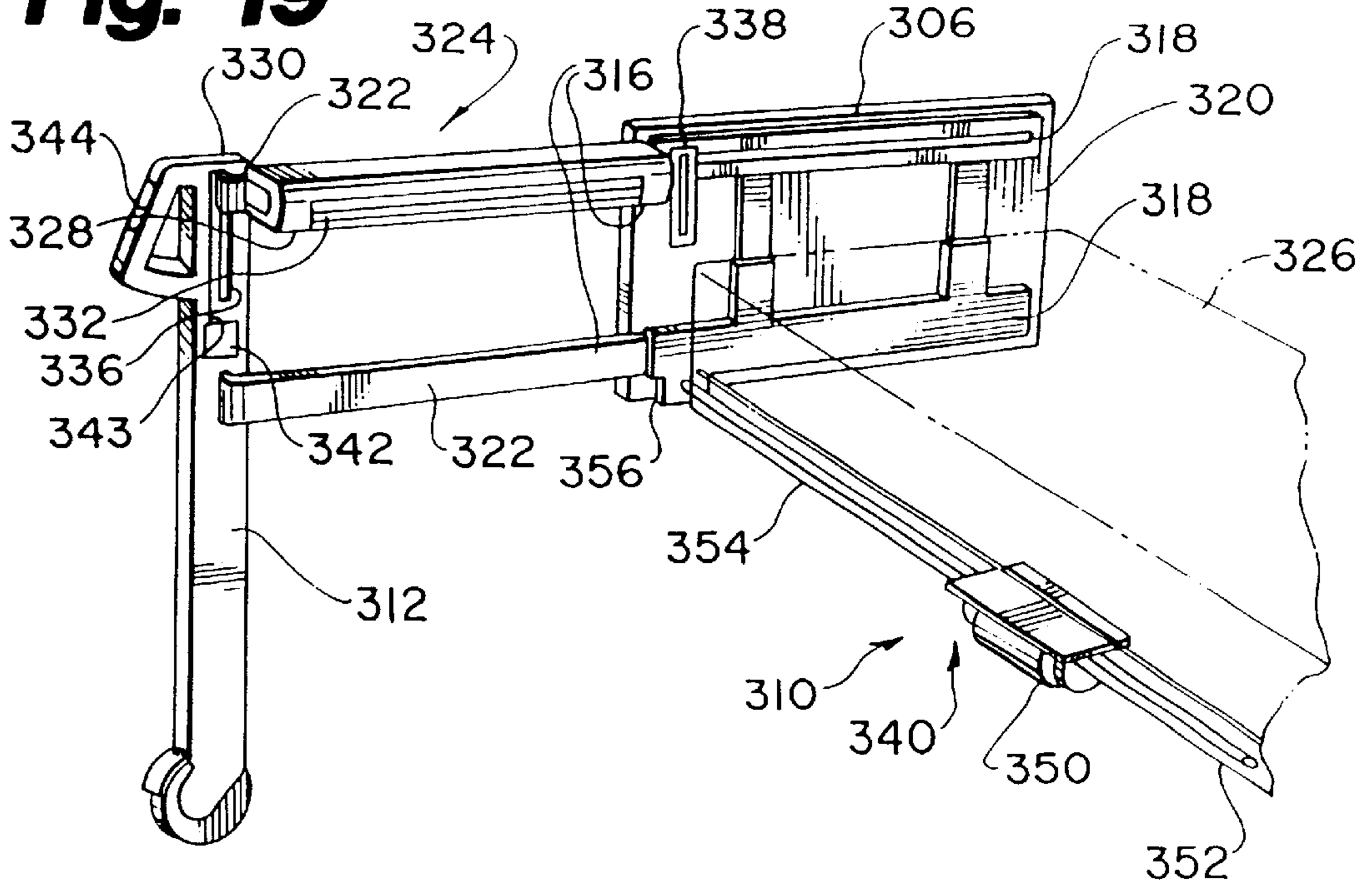




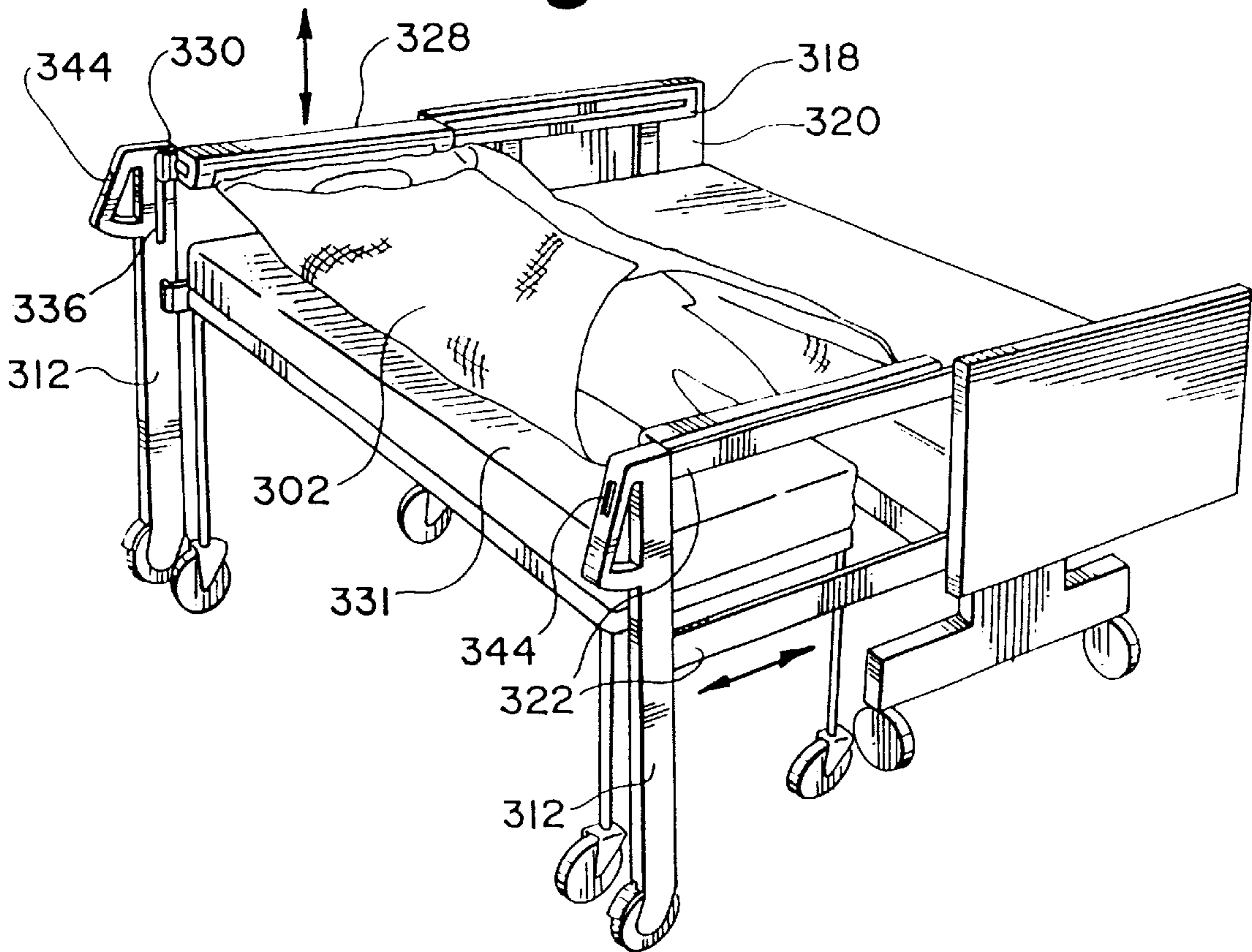




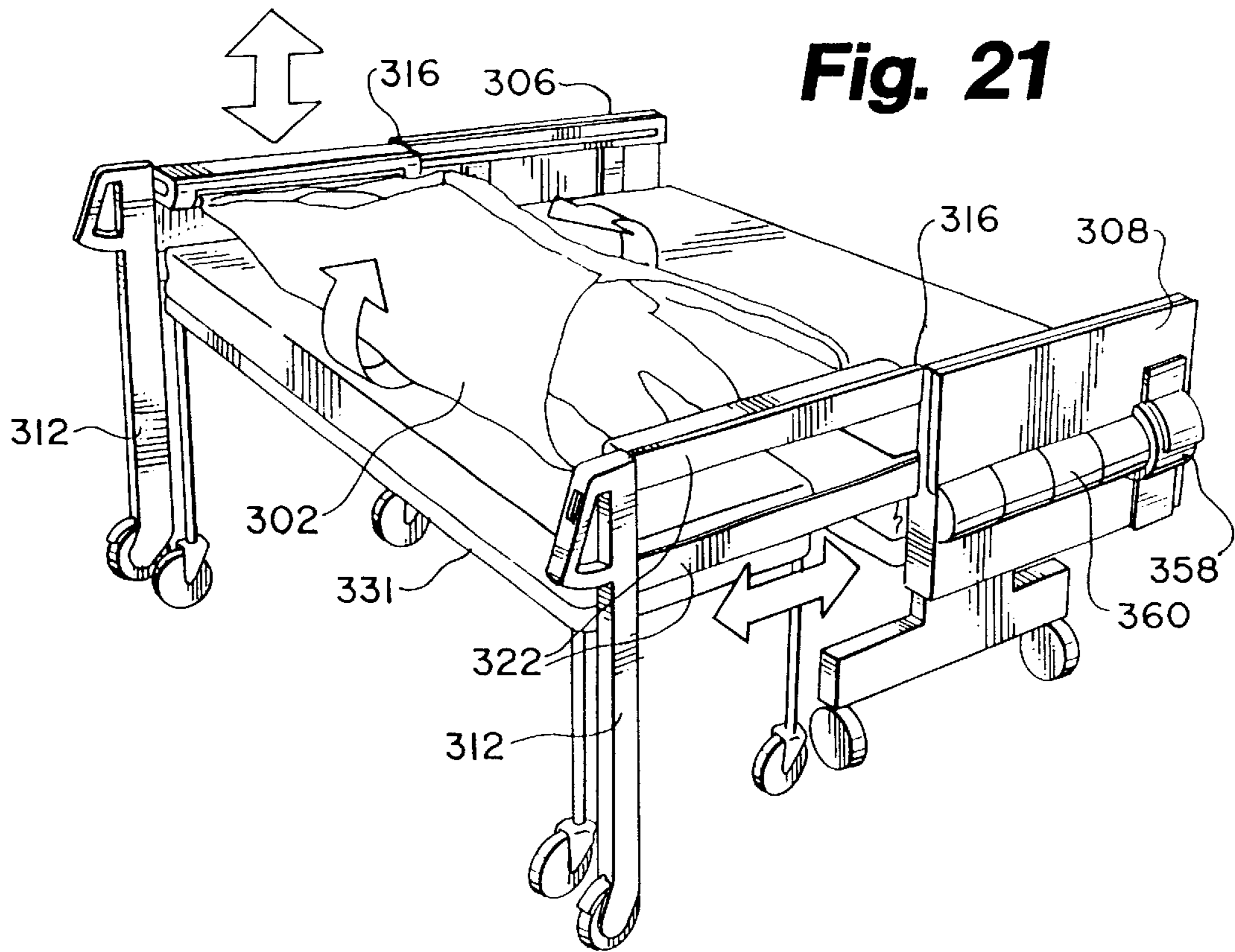
**Fig. 19**



**Fig. 20**

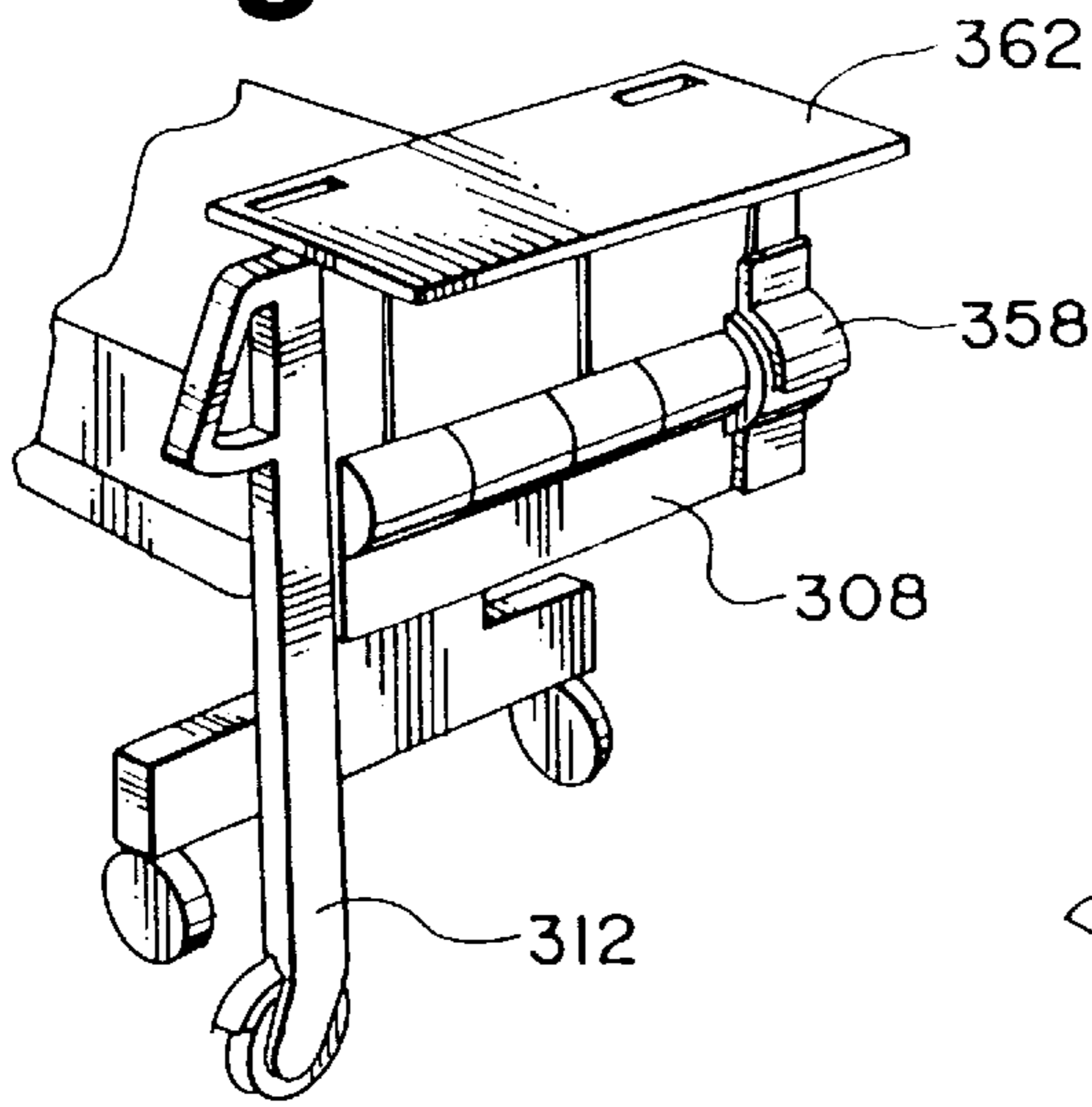




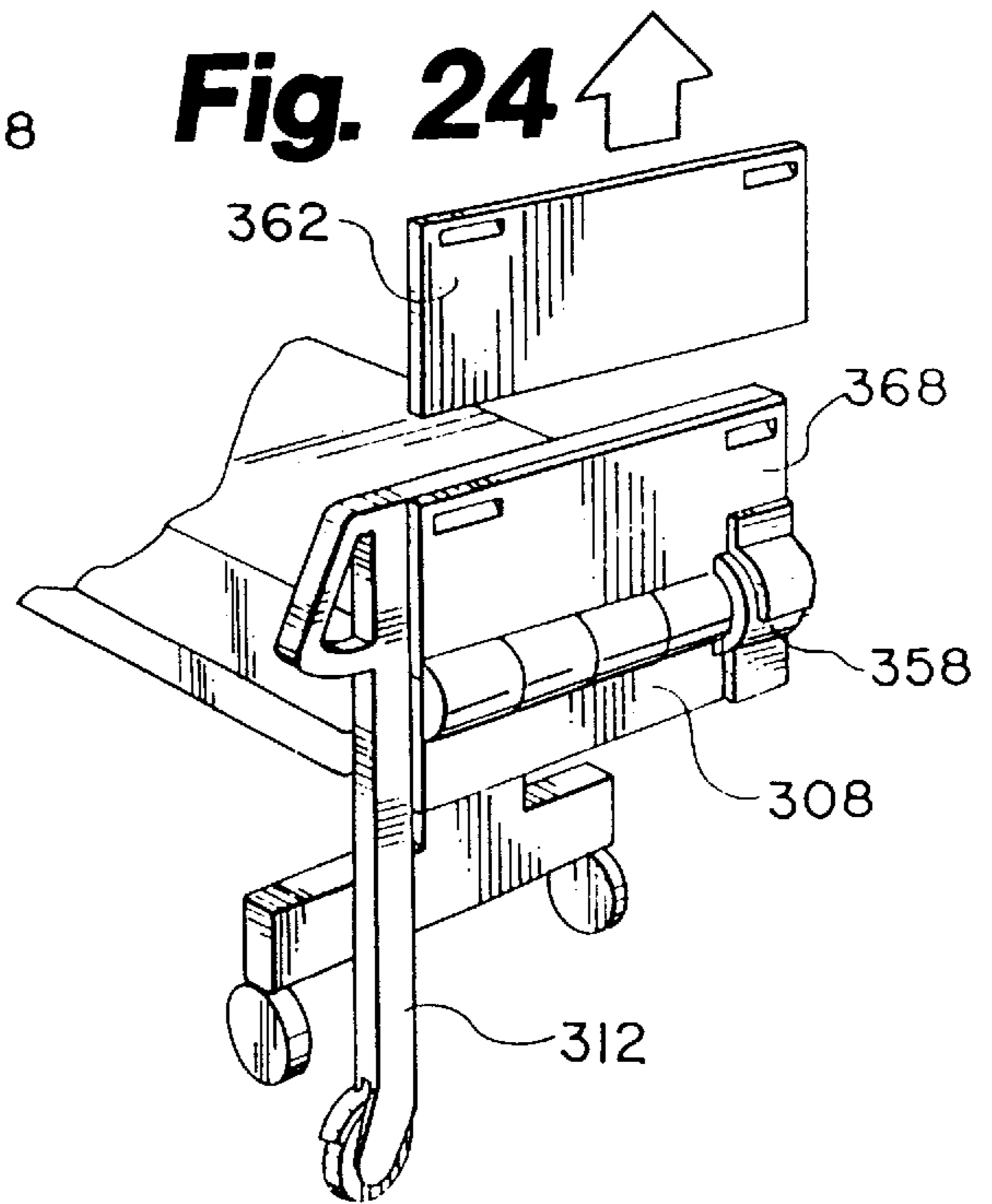


**Fig. 21**

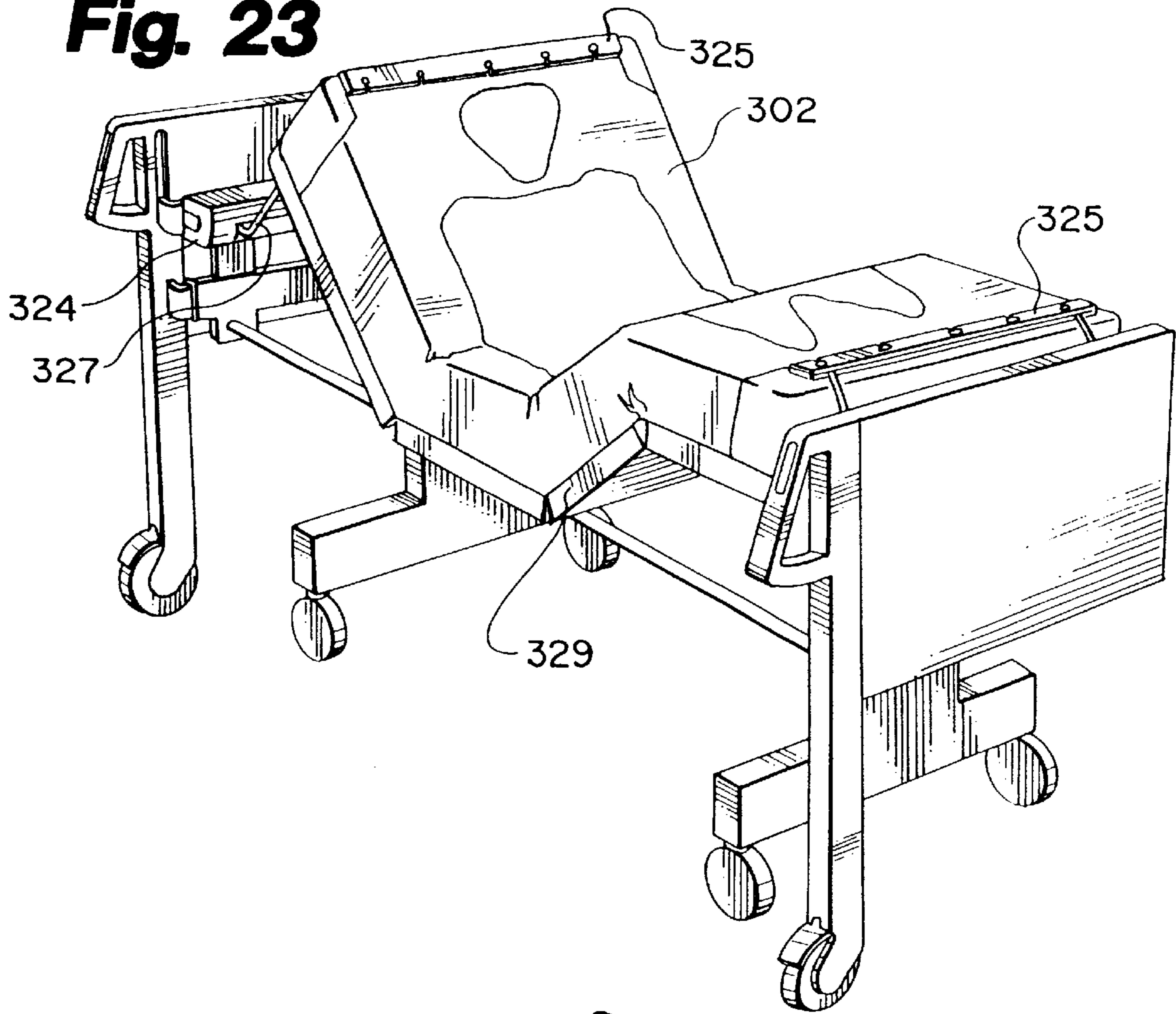
**Fig. 25**



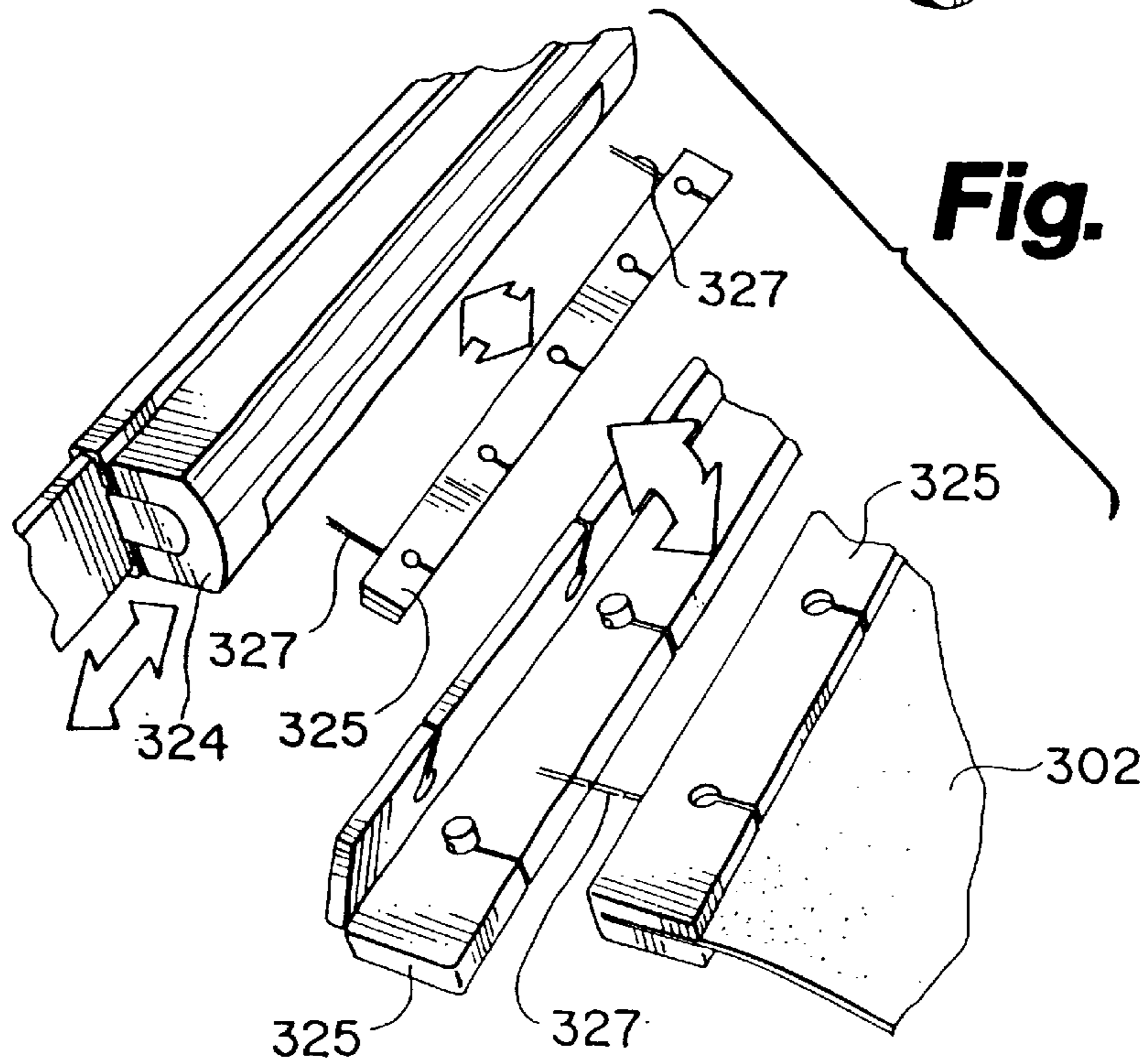
**Fig. 24**



**Fig. 23**

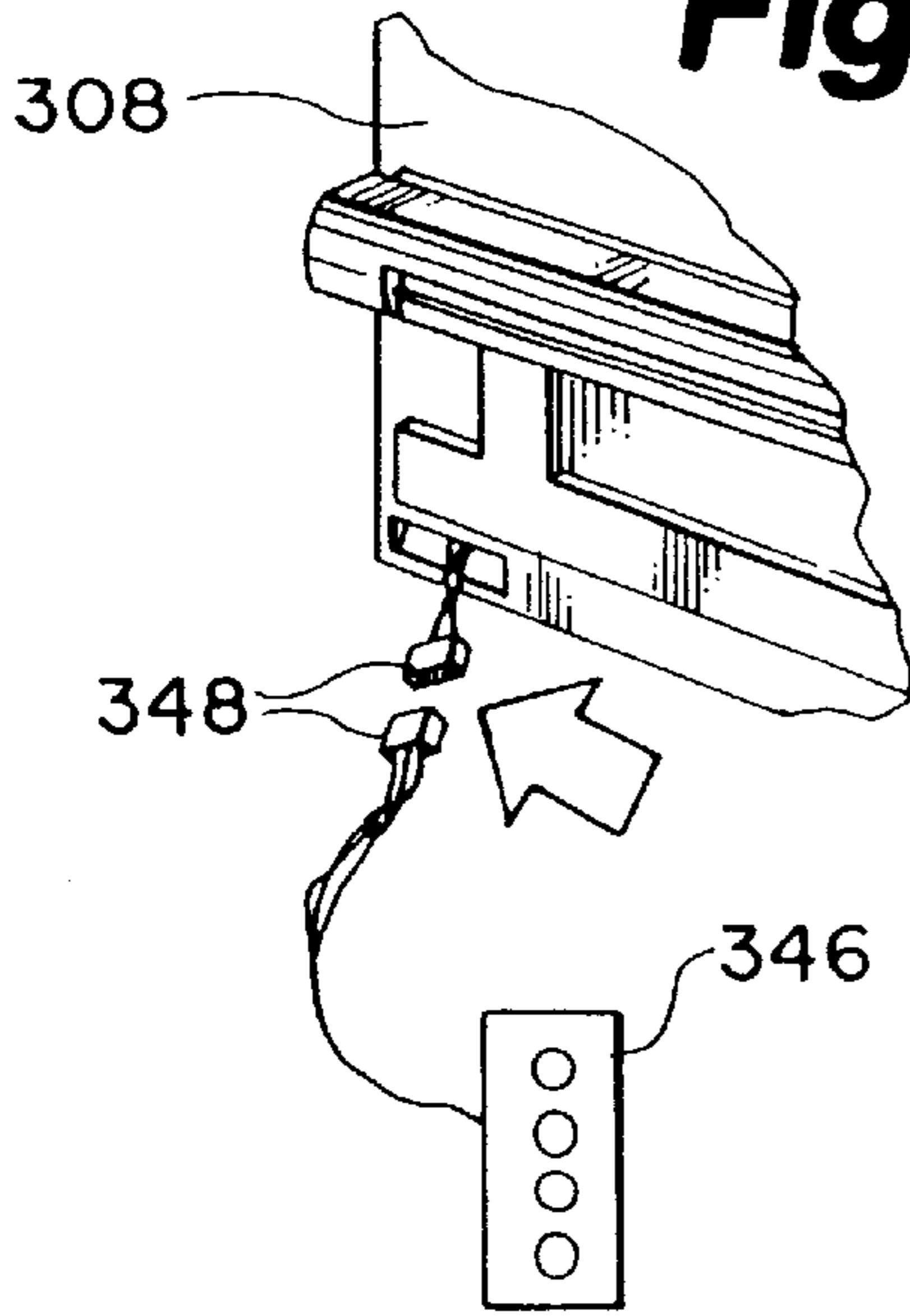


**Fig. 22**

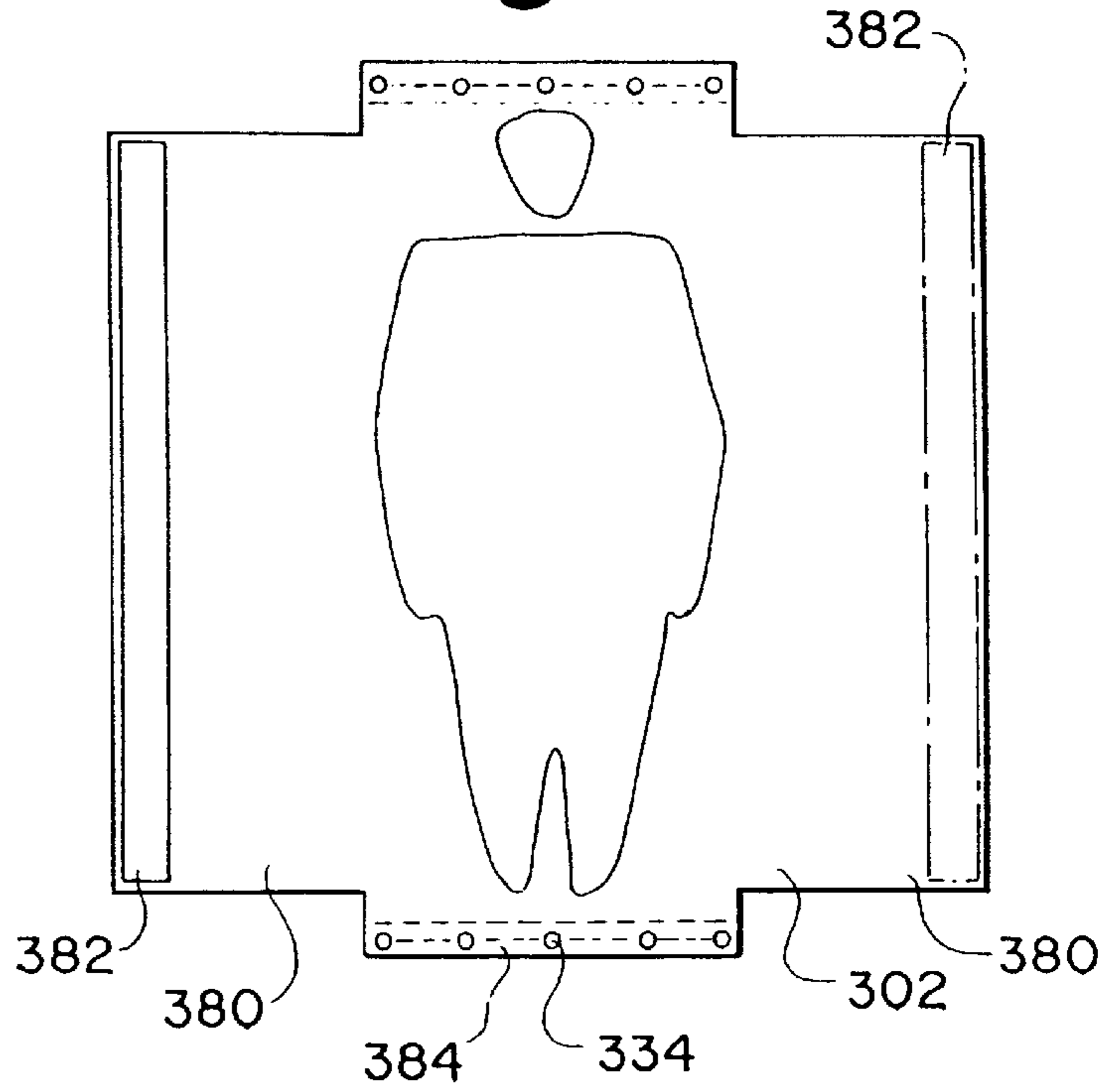




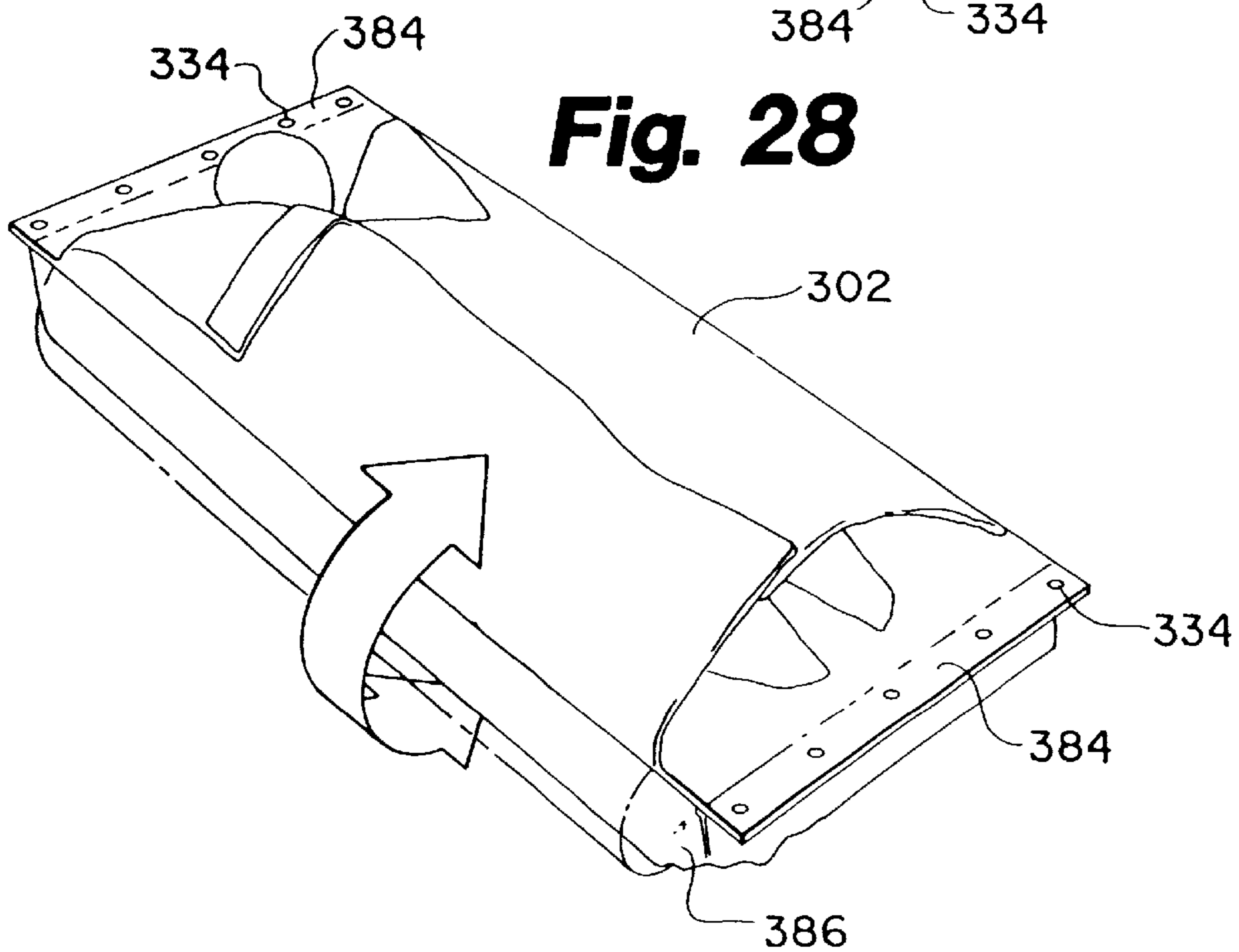
**Fig. 26**



**Fig. 27**



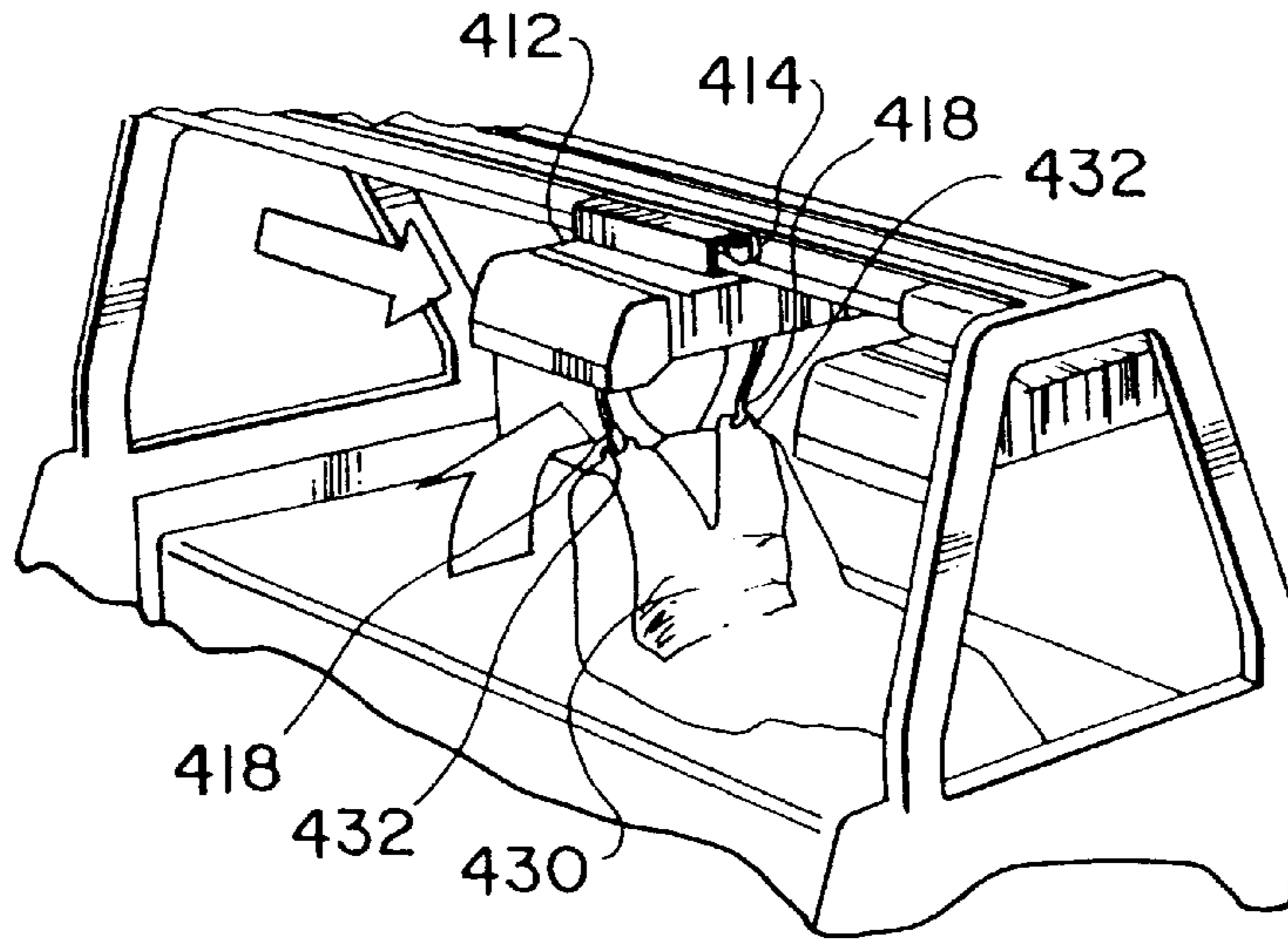
**Fig. 28**



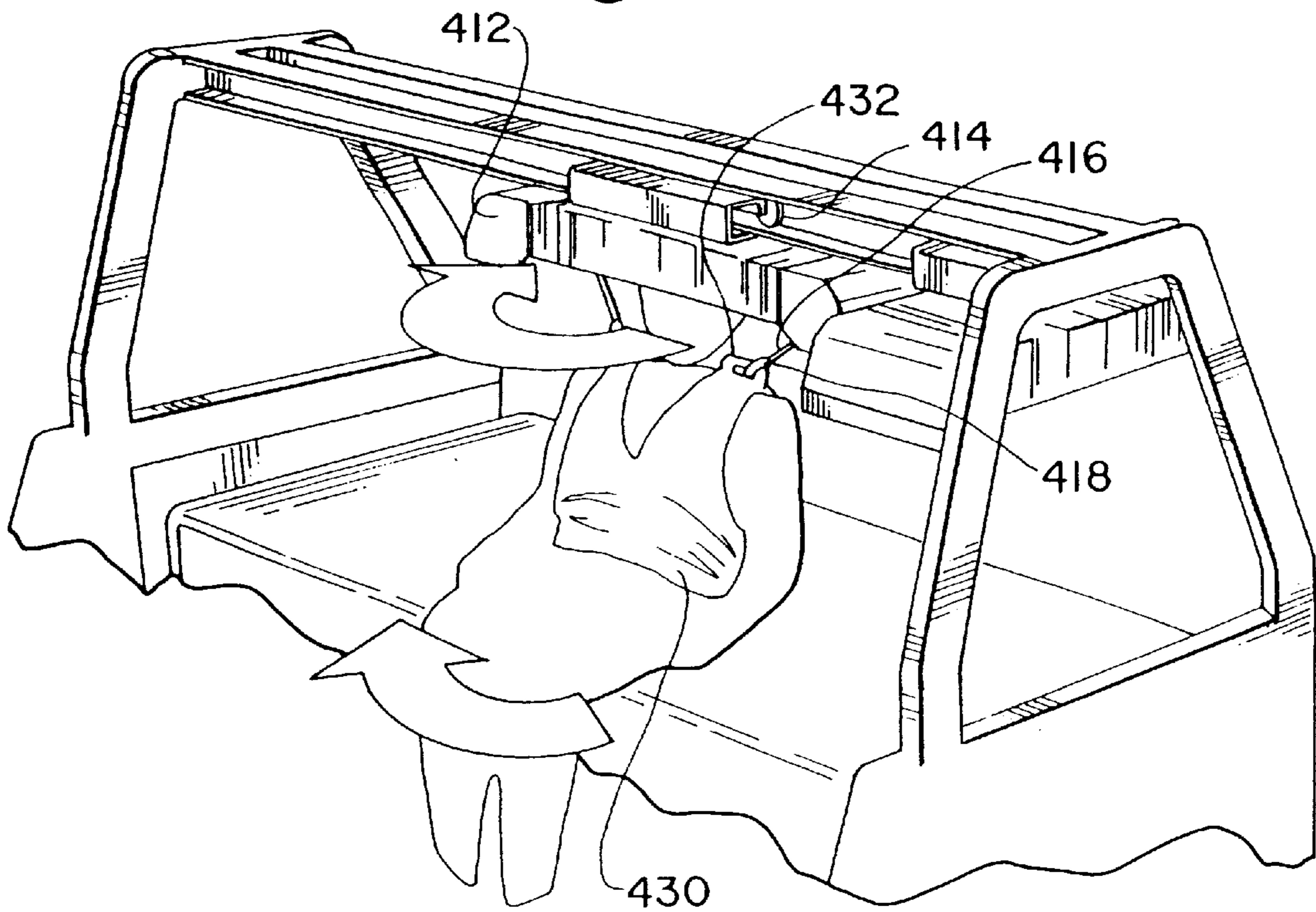




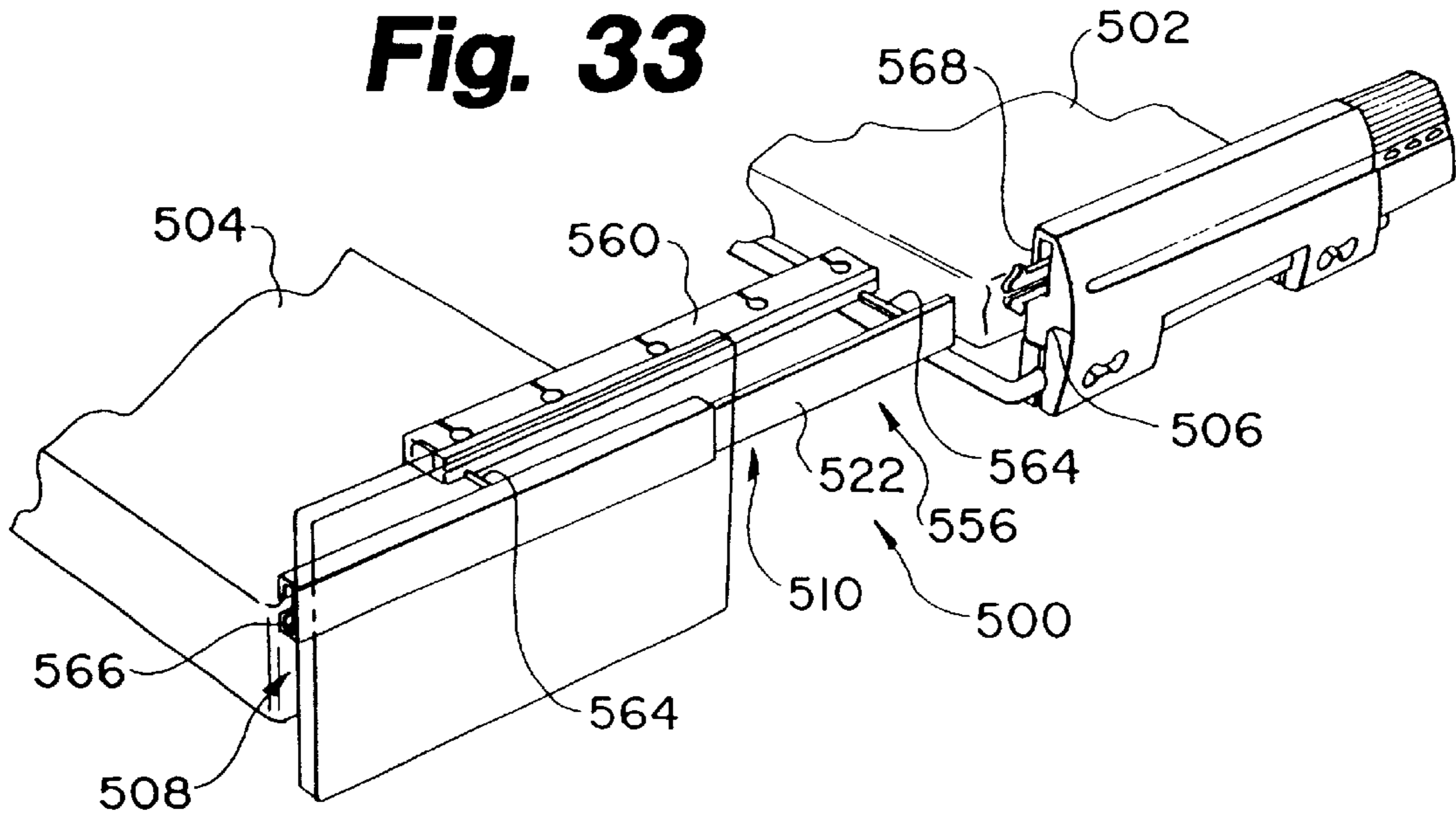
**Fig. 31**



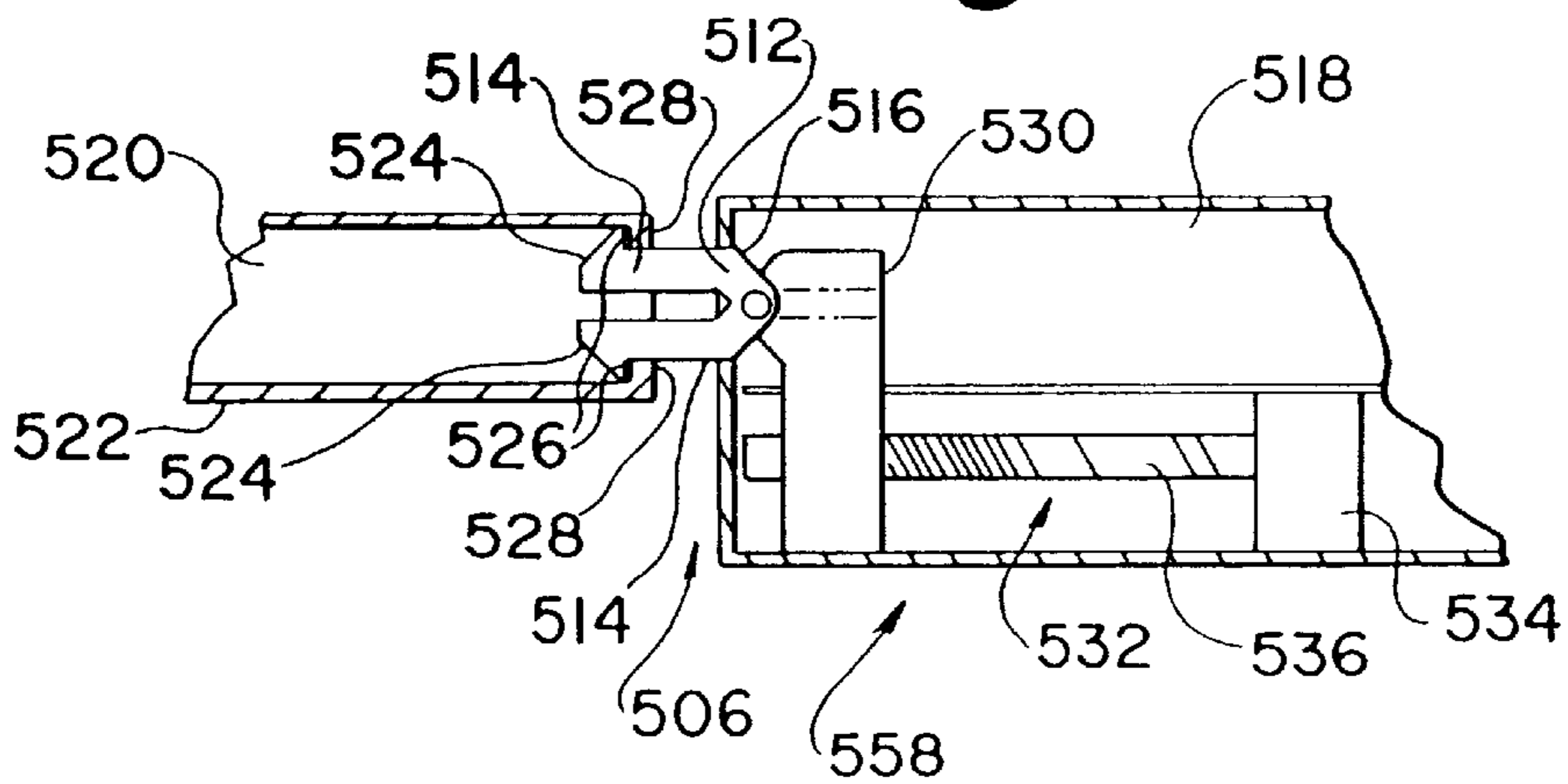
**Fig. 32**



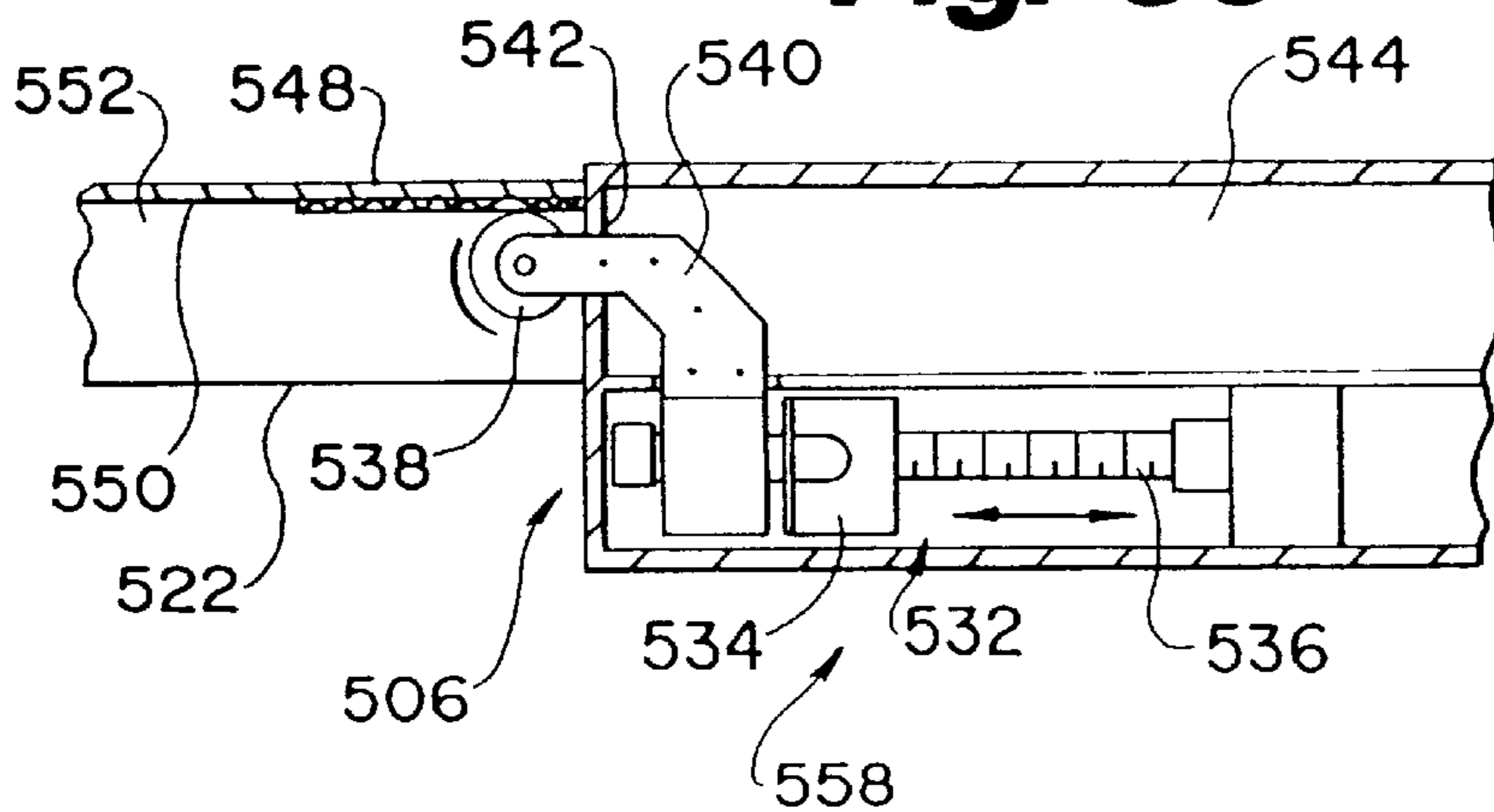
**Fig. 33**

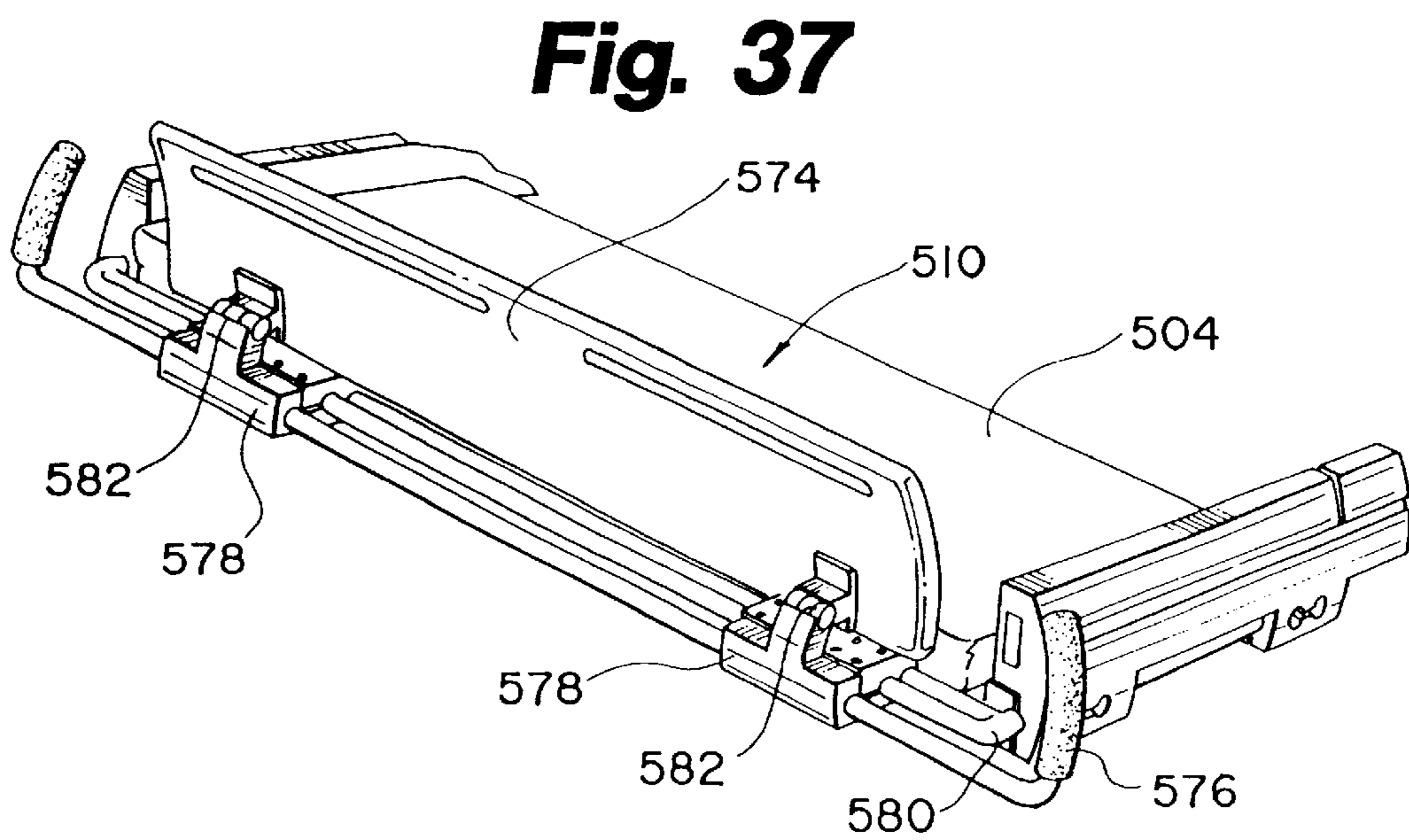
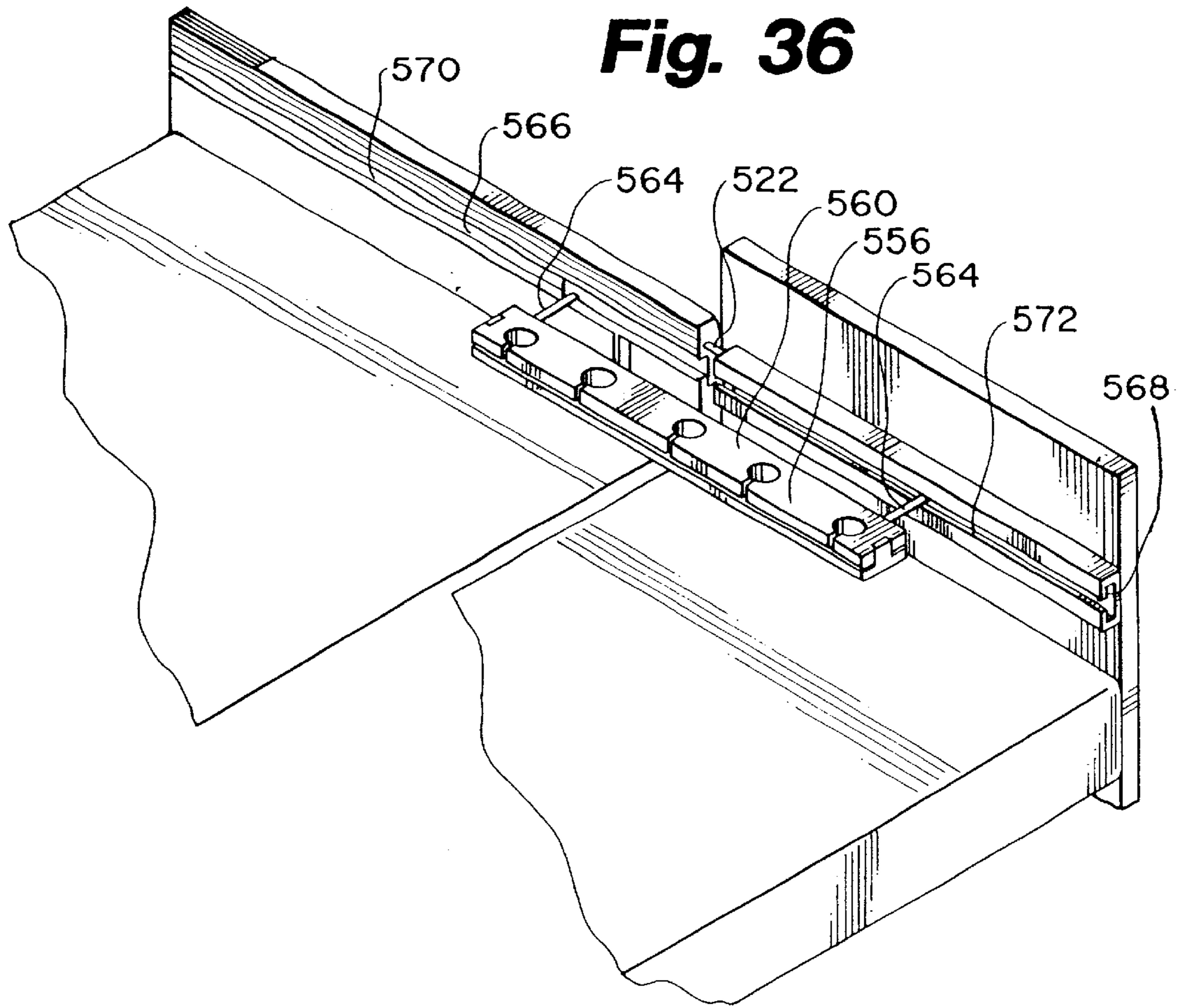


**Fig. 34**

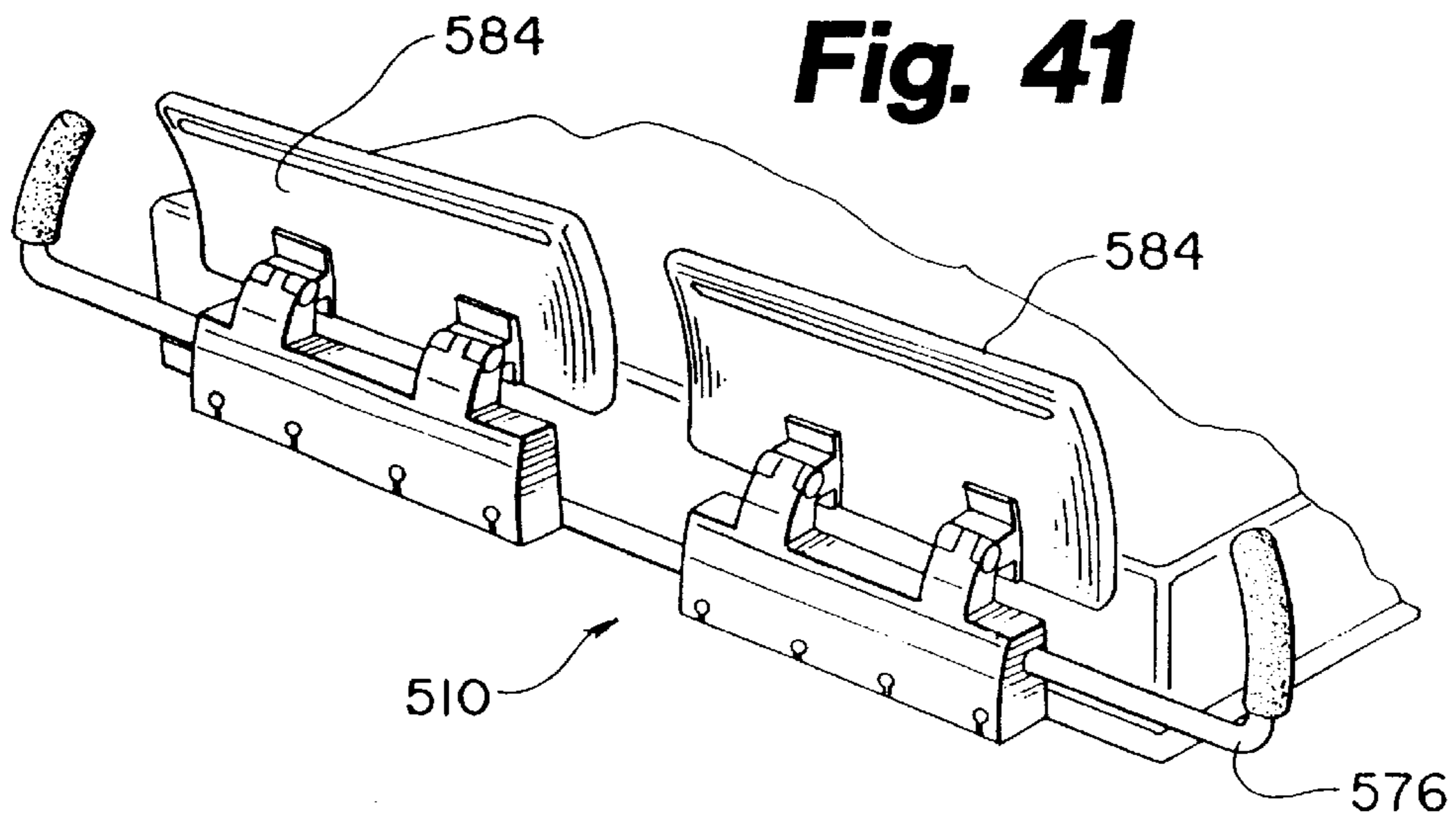
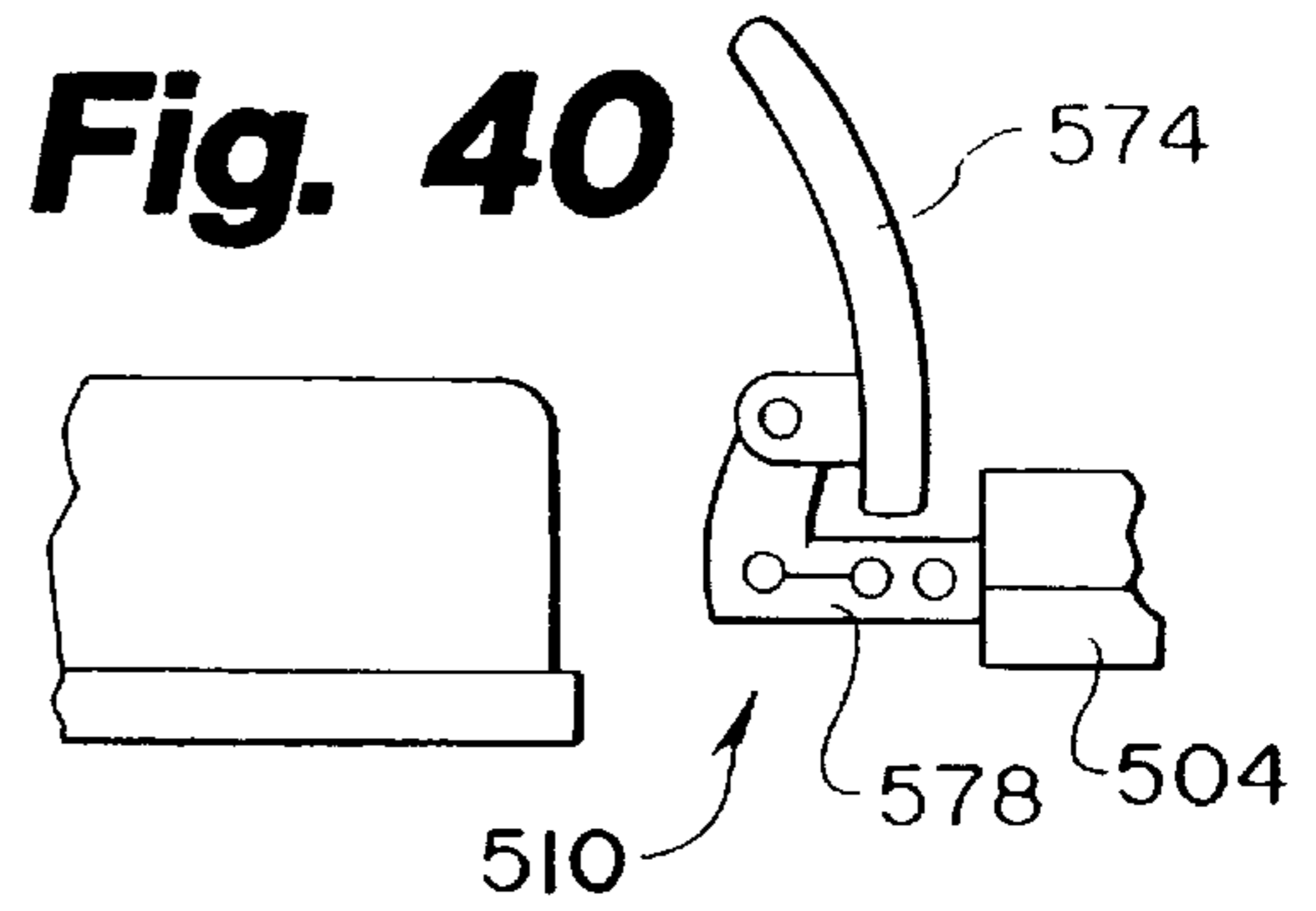
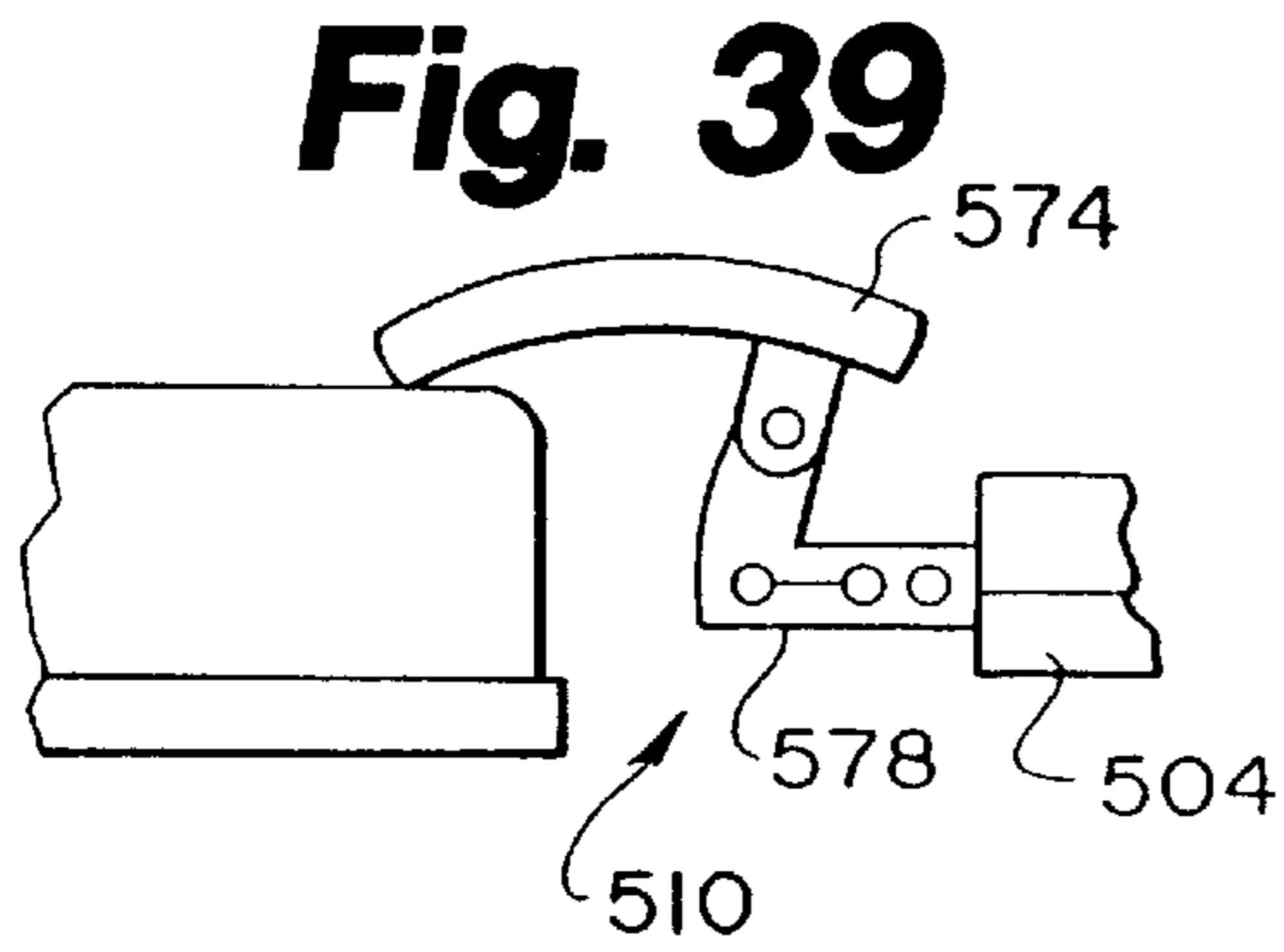
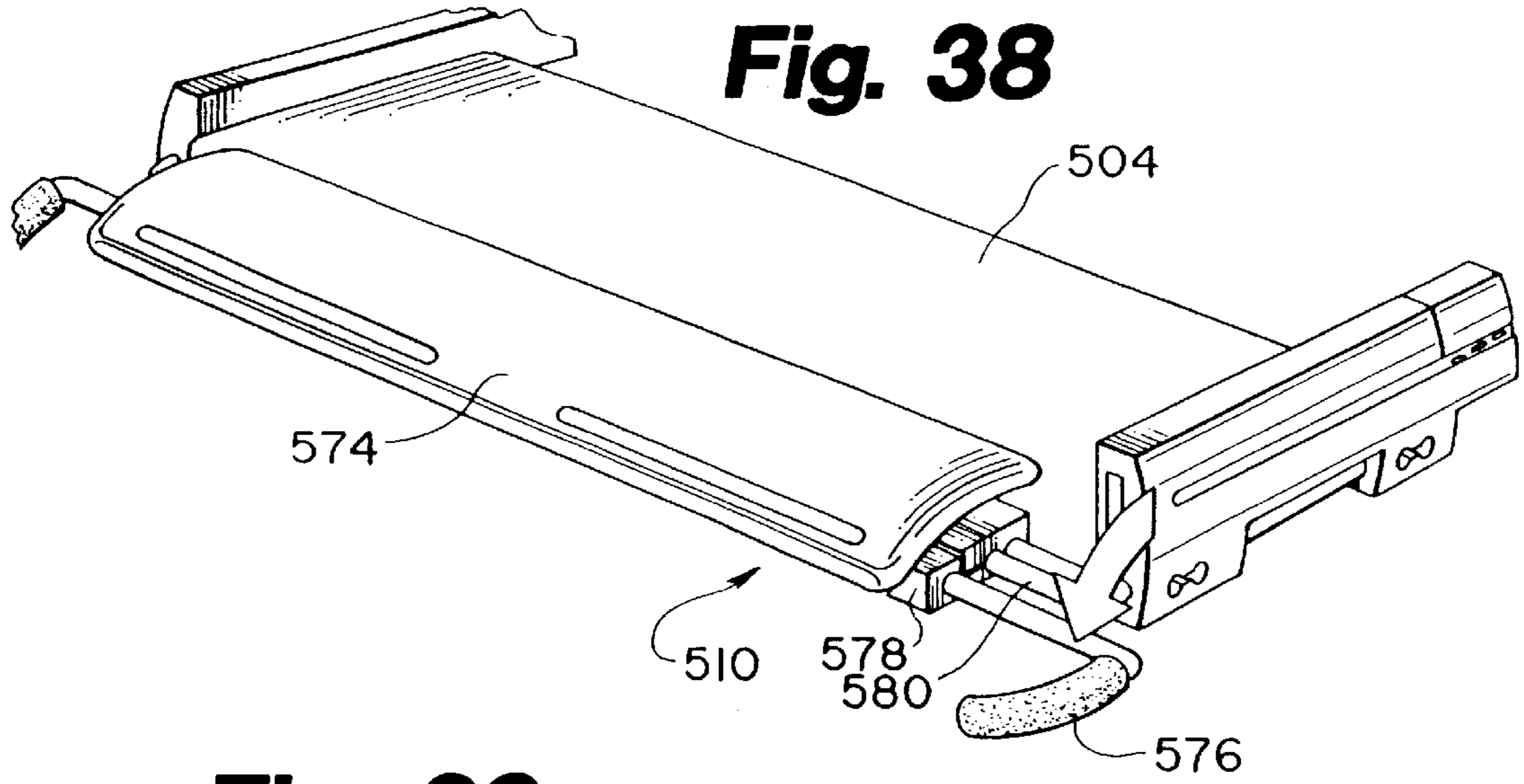


**Fig. 35**

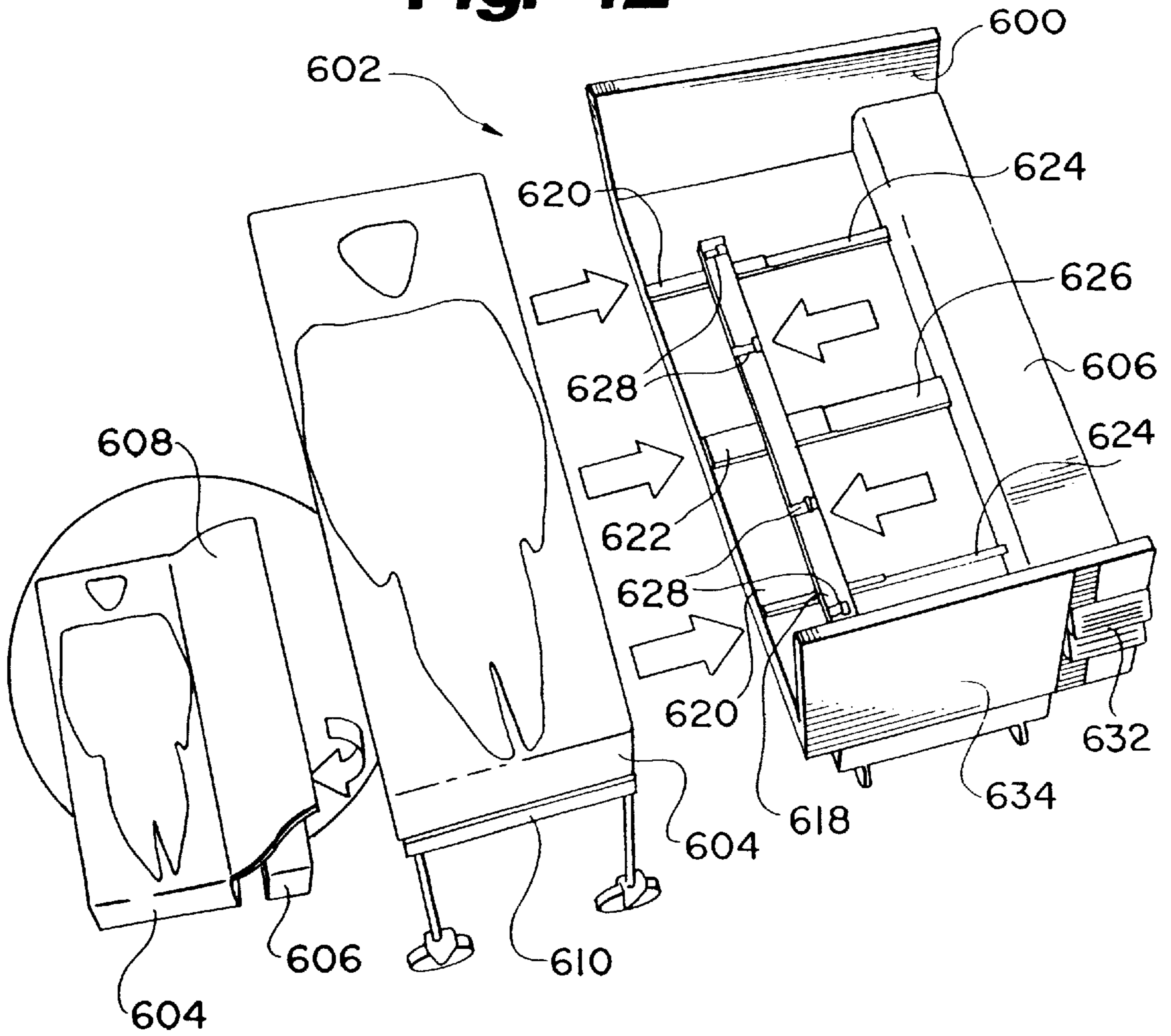




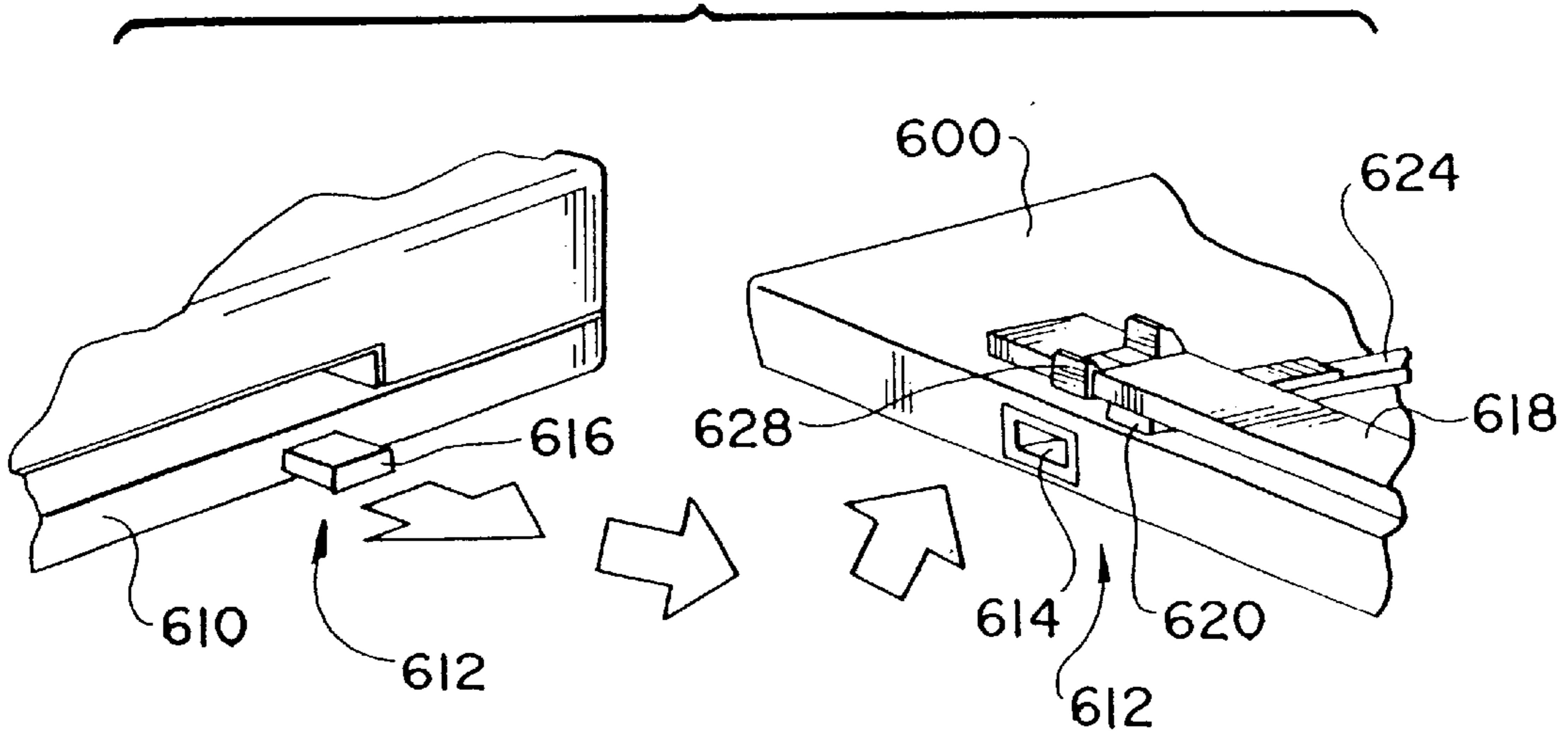




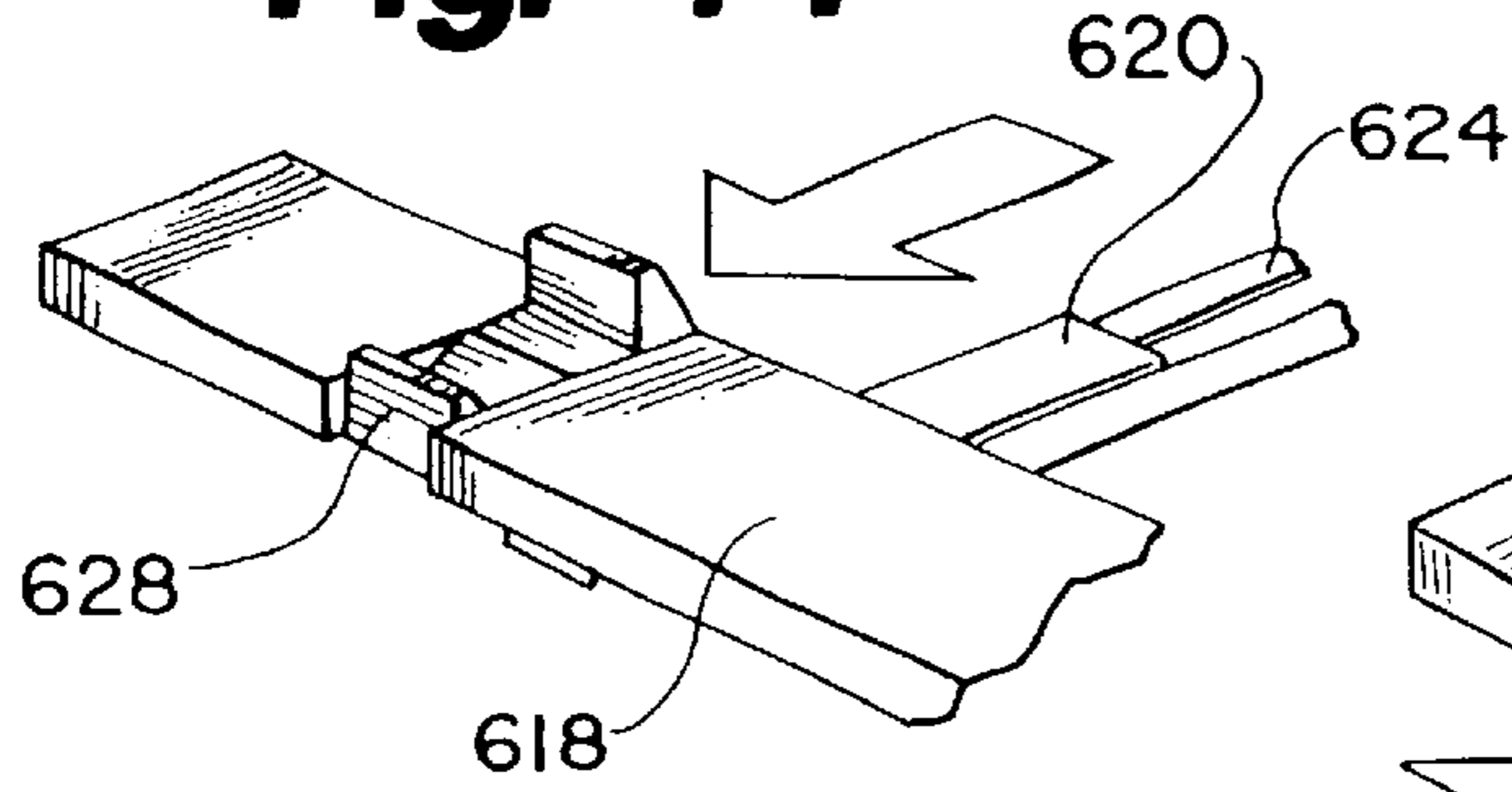
**Fig. 42**



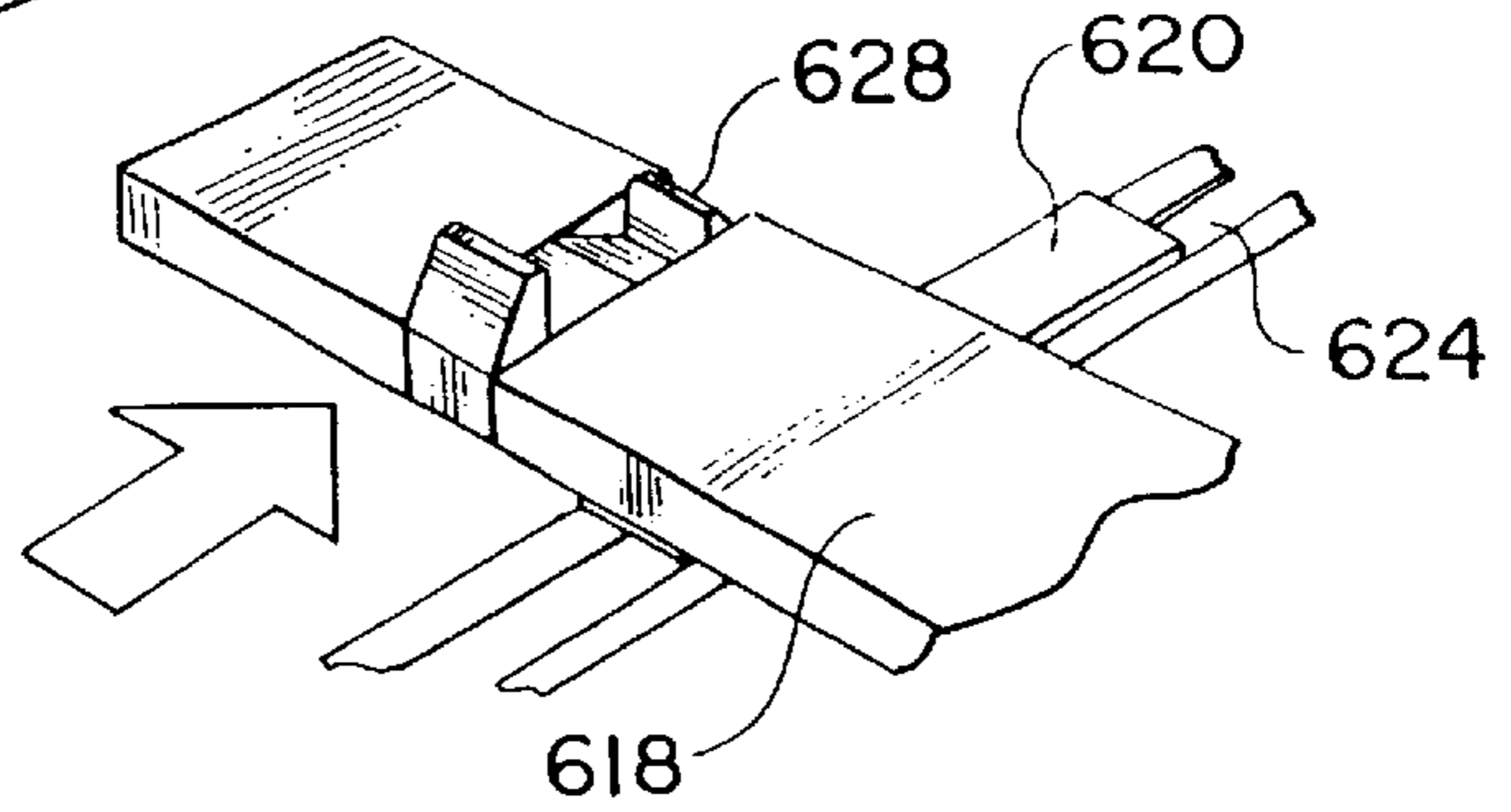
**Fig. 43**



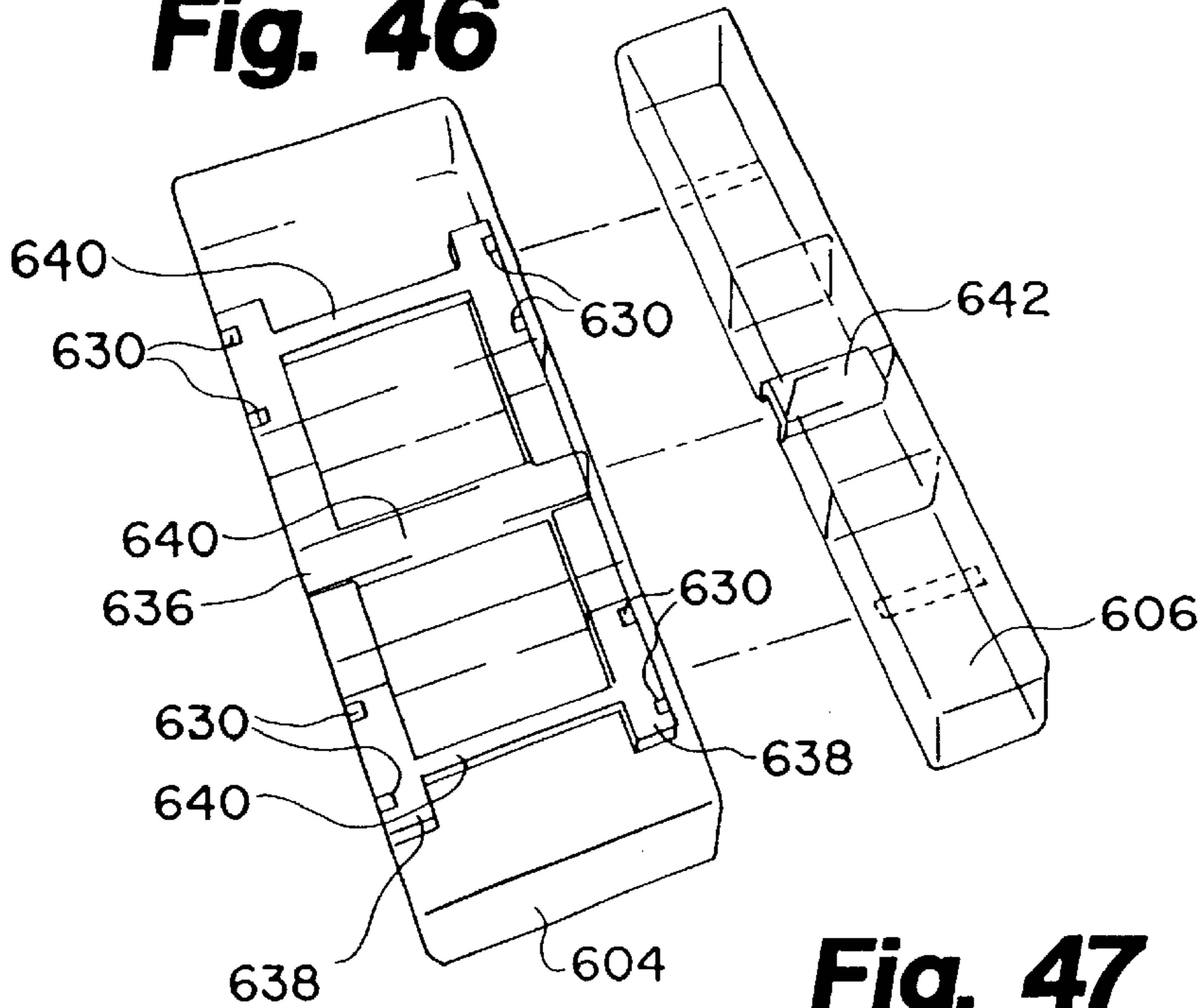
**Fig. 44**



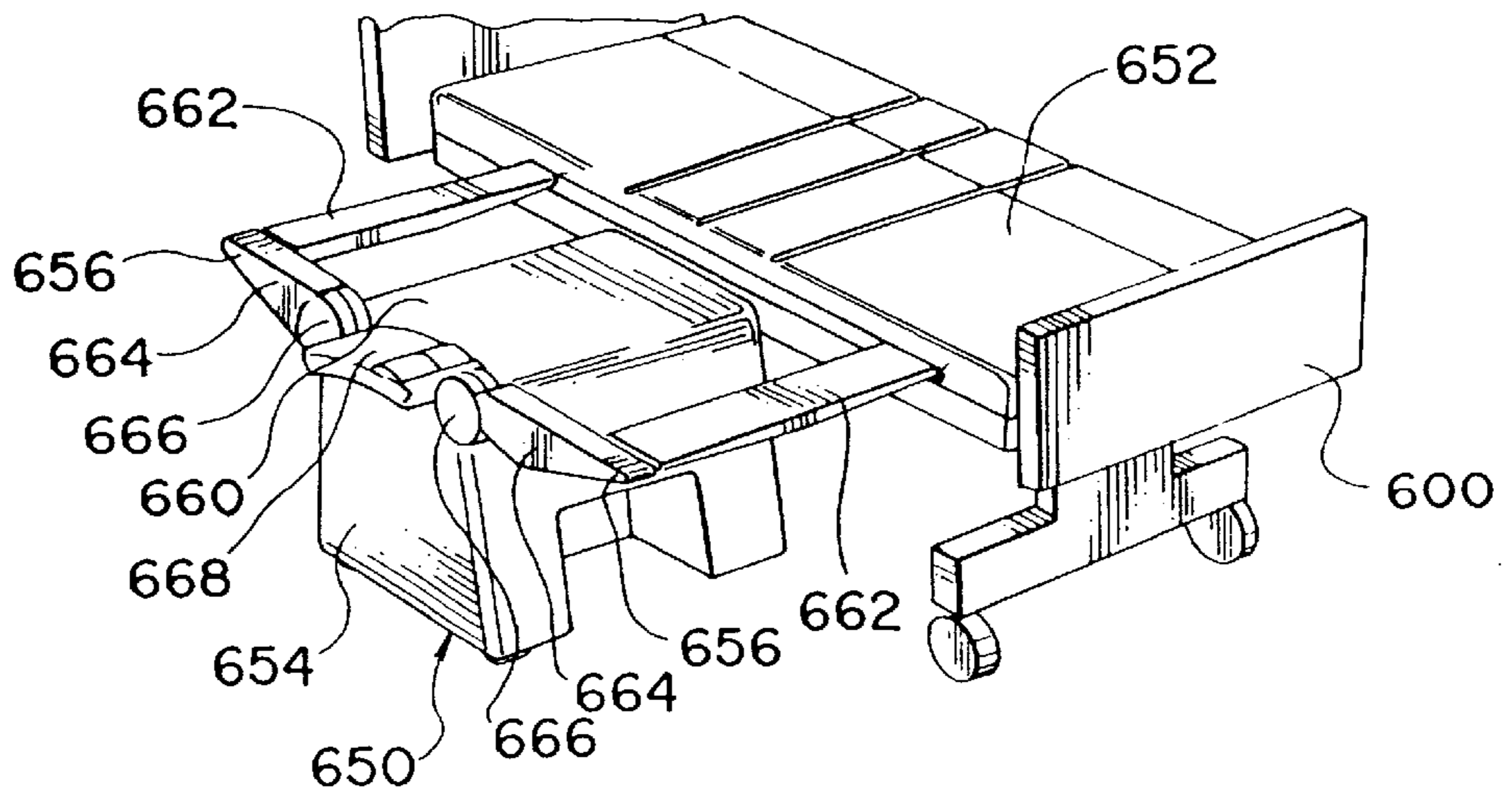
**Fig. 45**



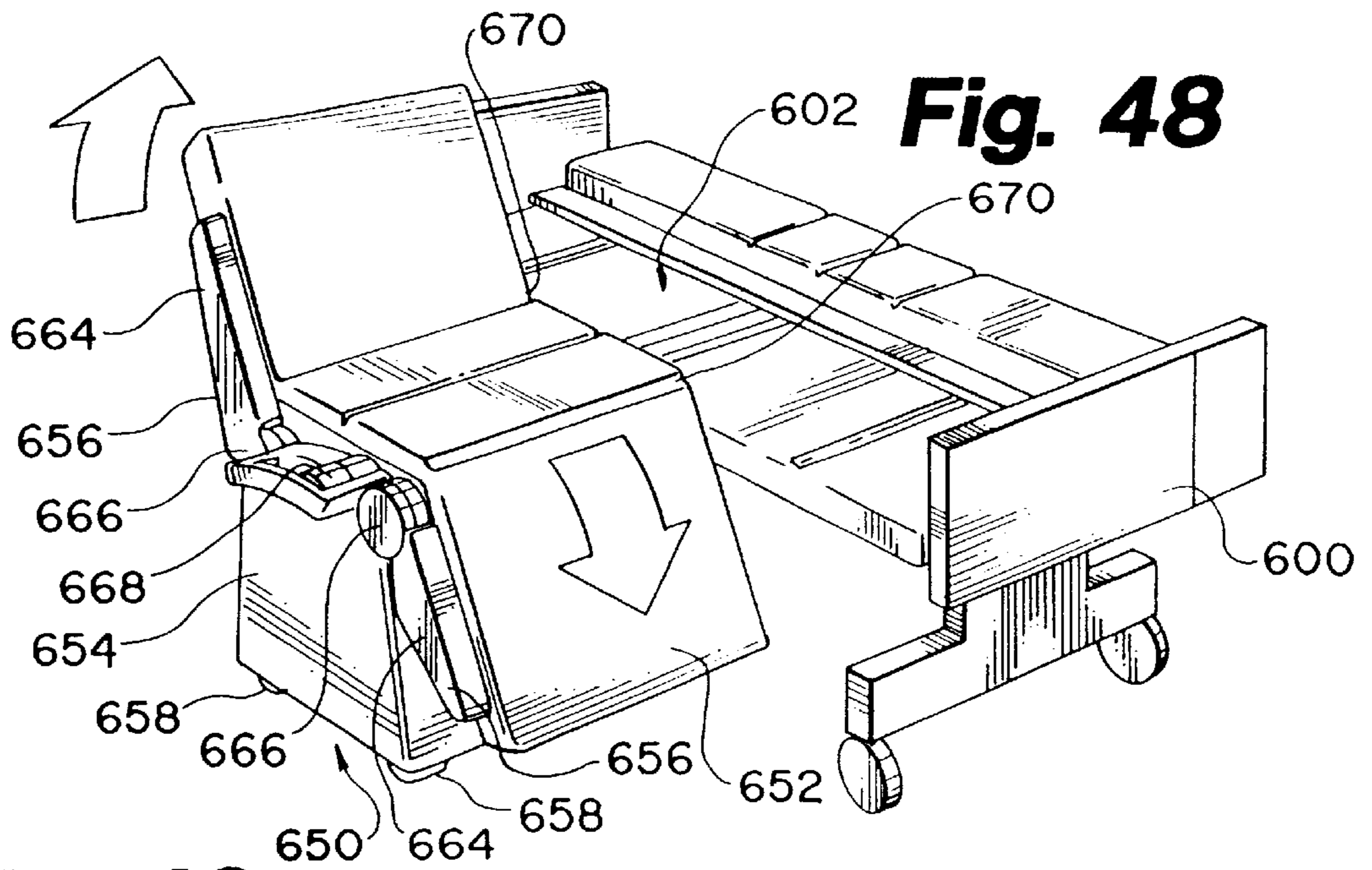
**Fig. 46**



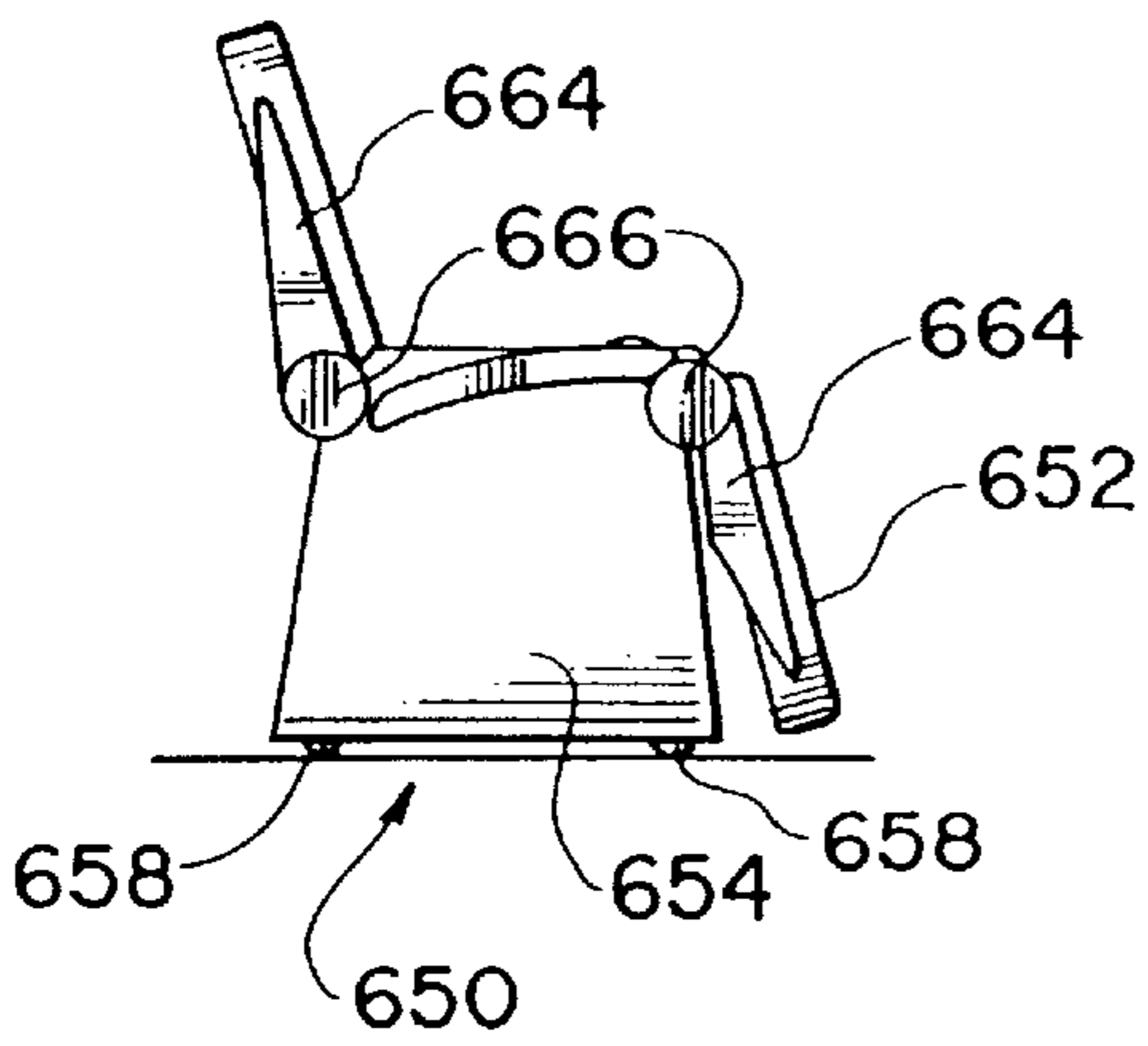
**Fig. 47**



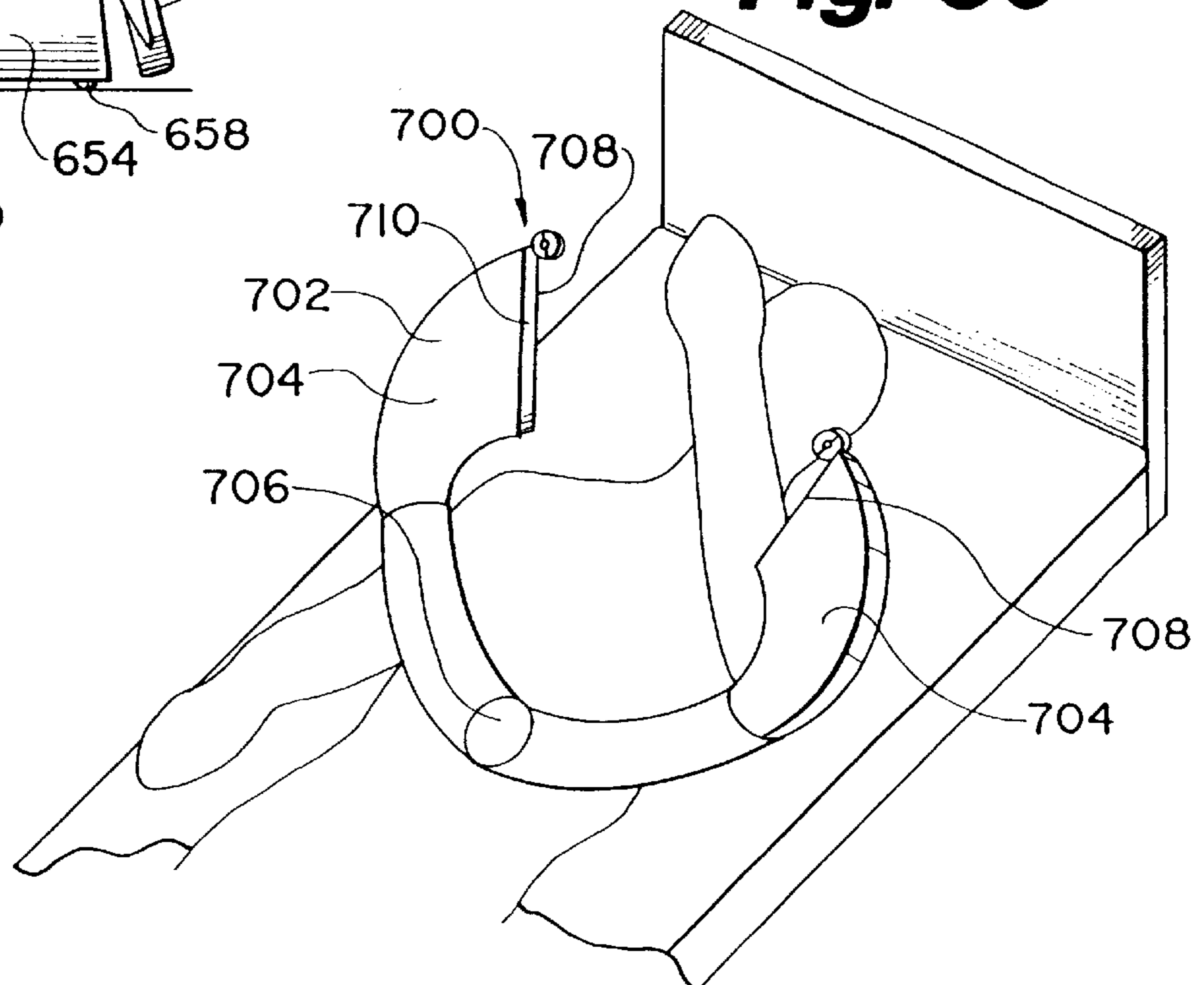


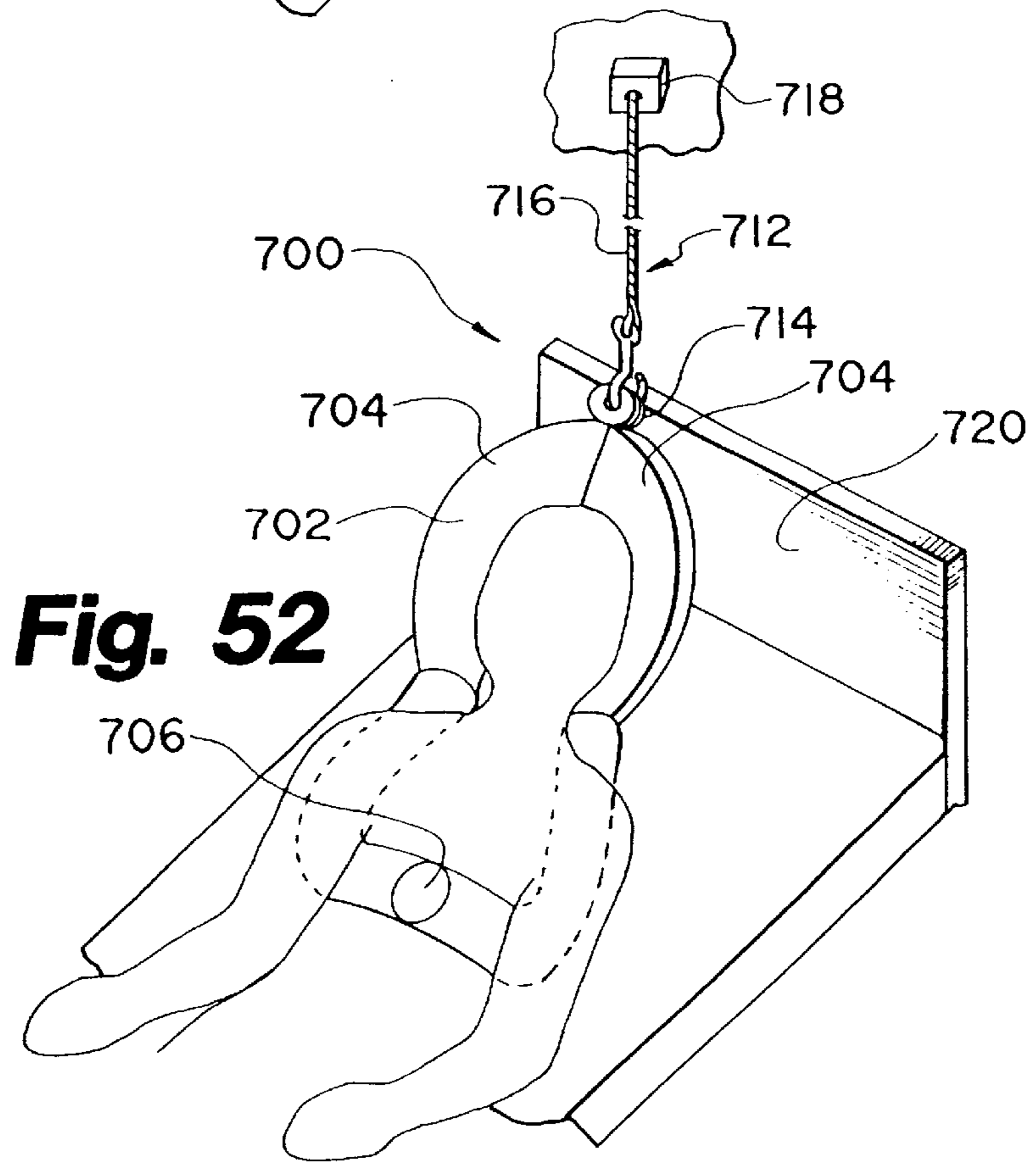
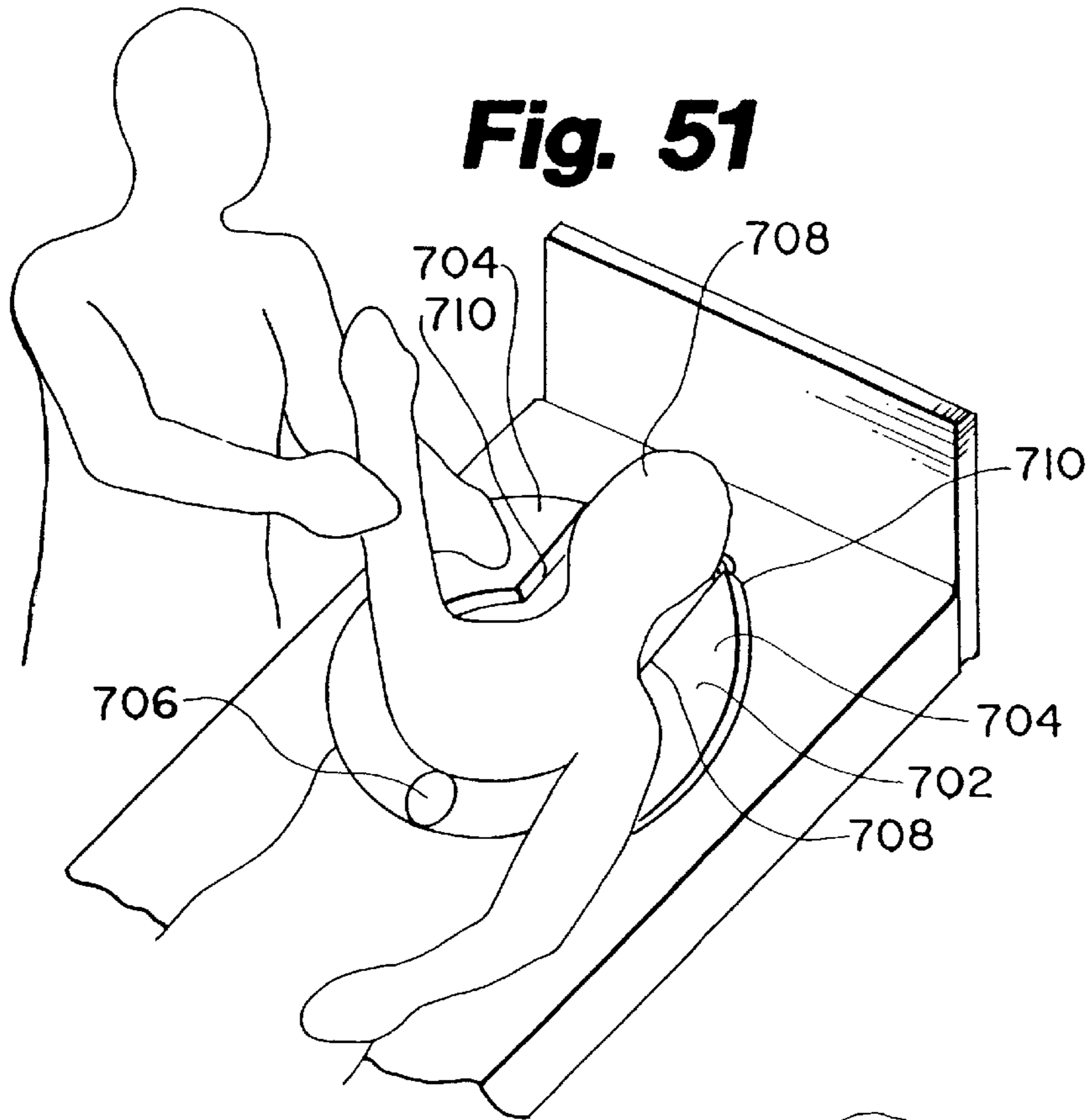


**Fig. 49**

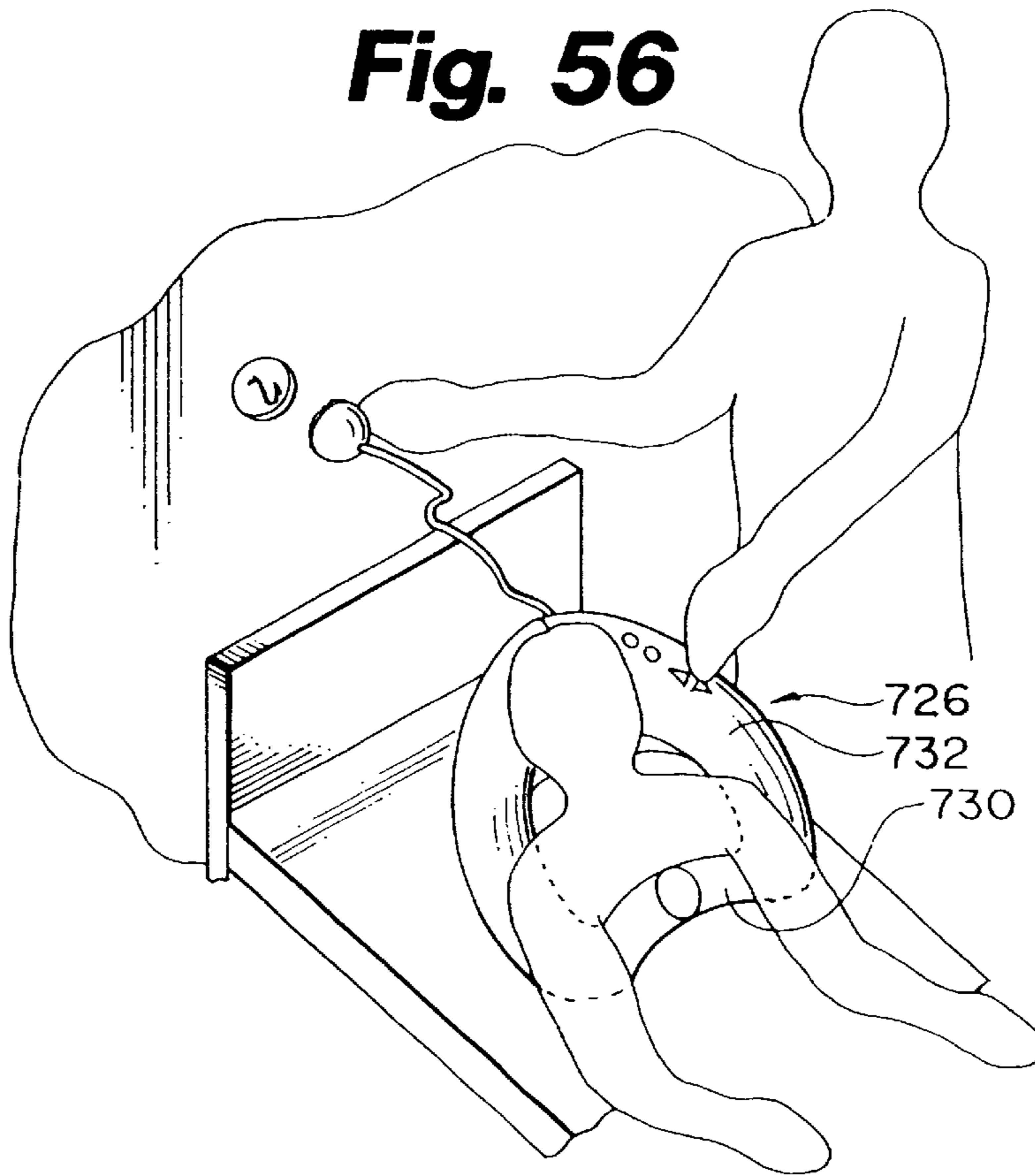


**Fig. 50**

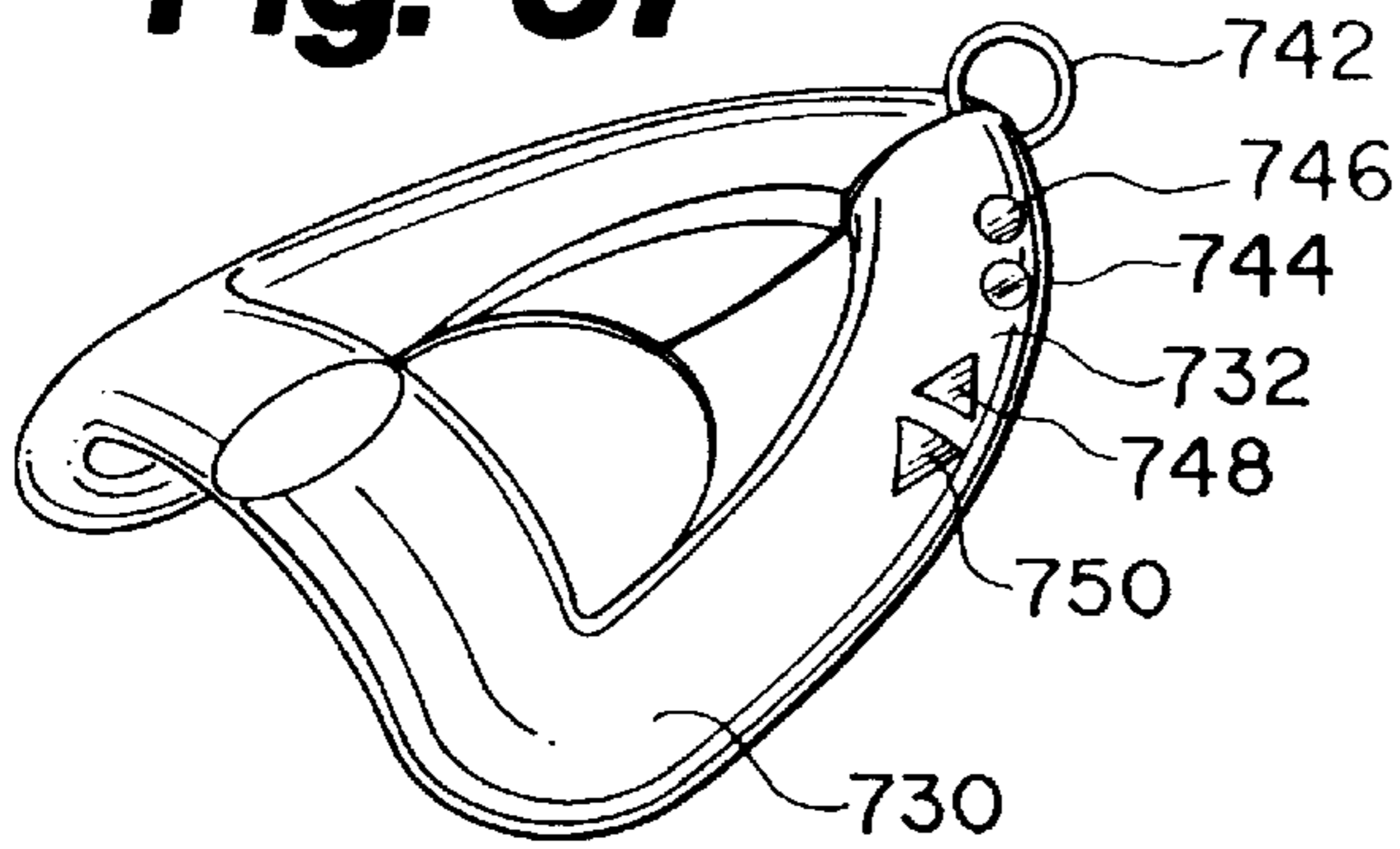




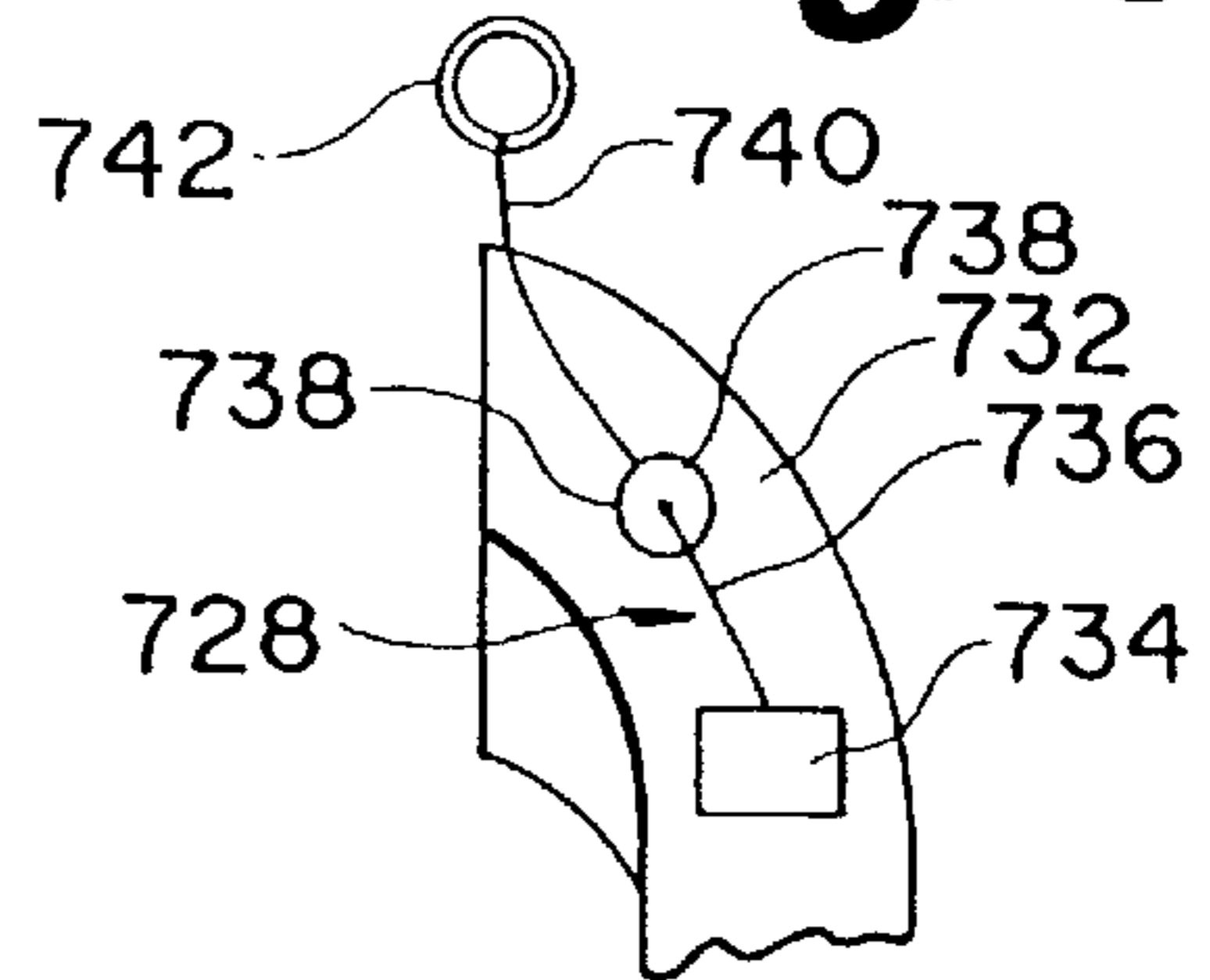
**Fig. 56**



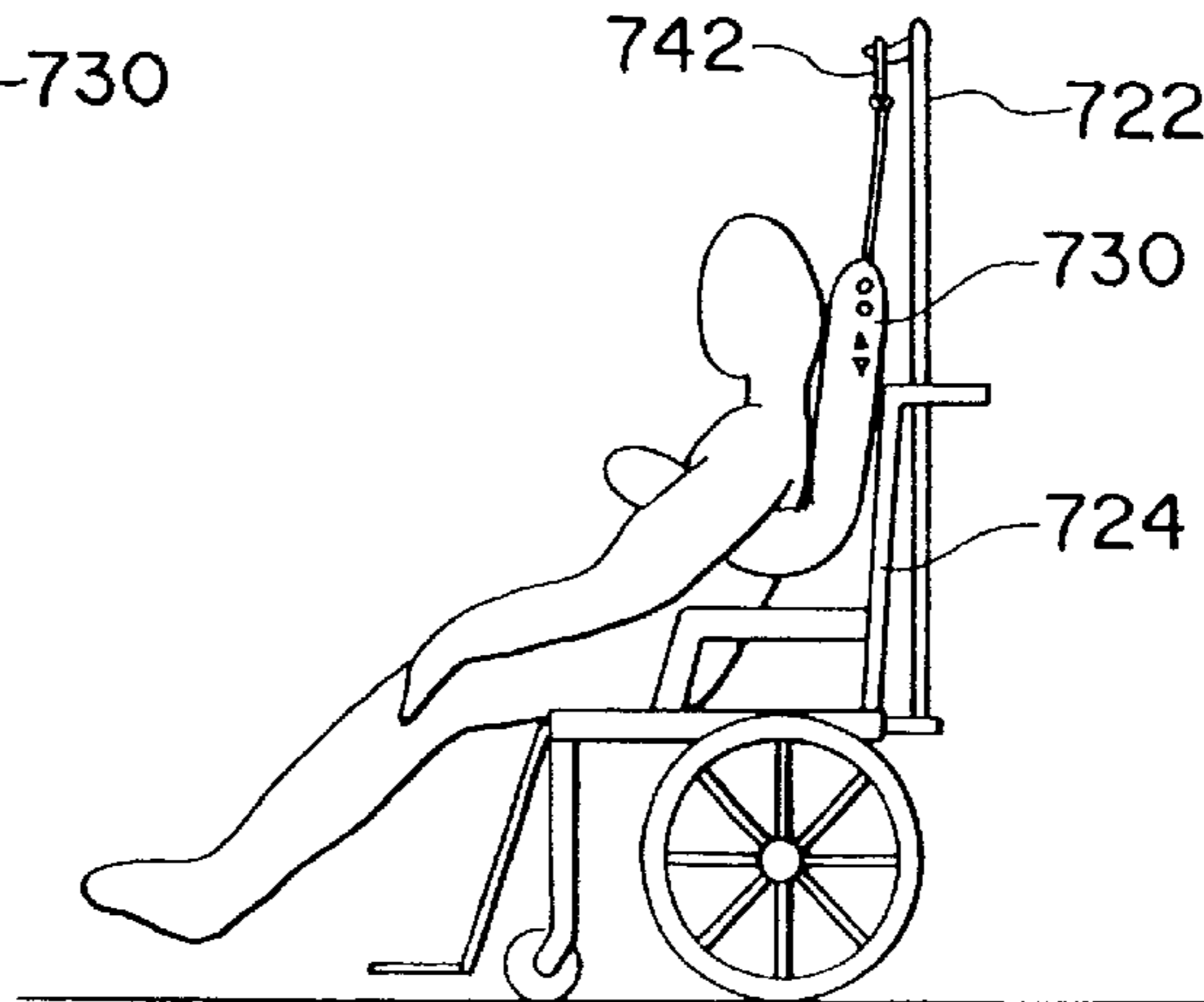
**Fig. 57**



**Fig. 58**



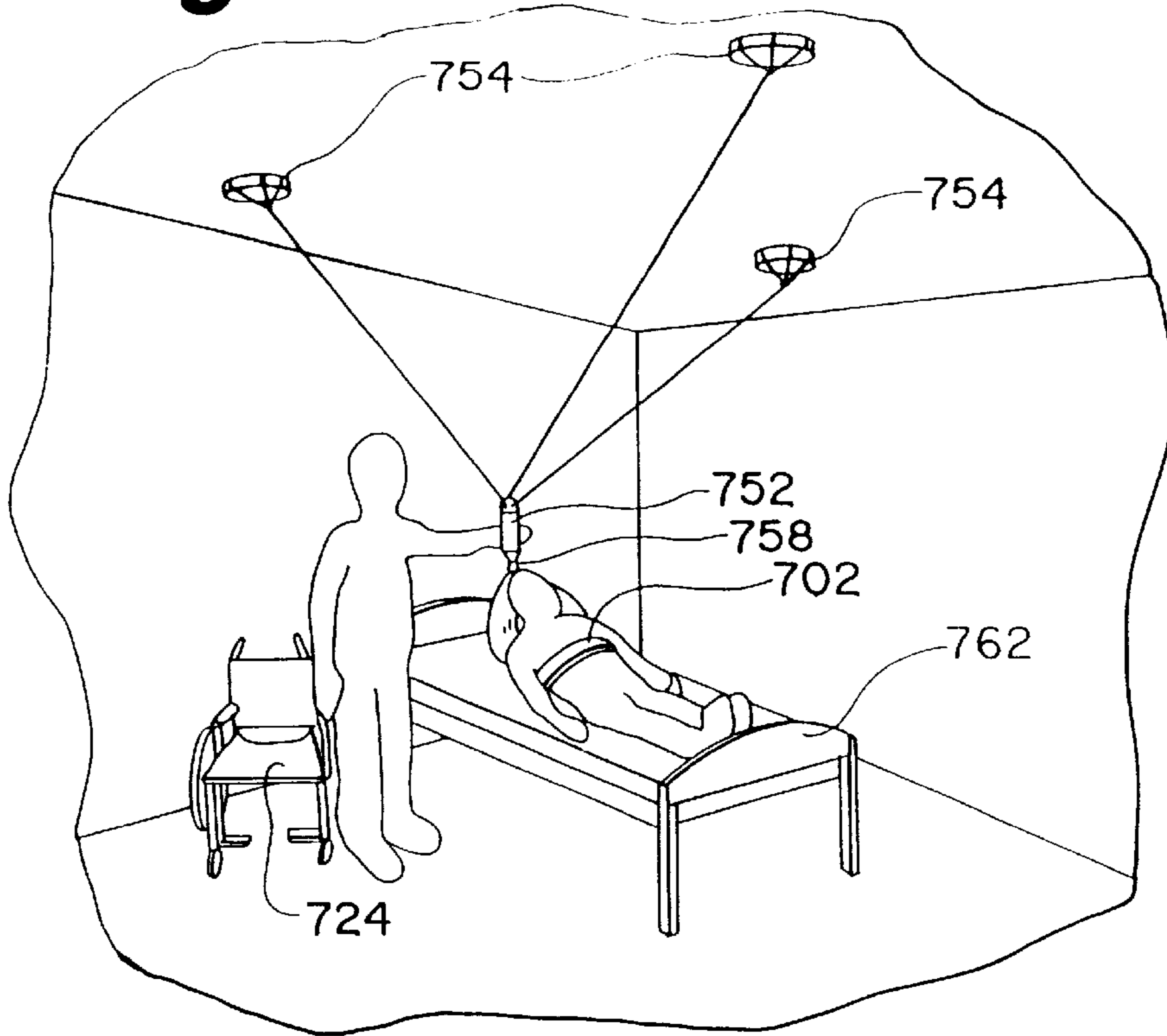
**Fig. 53**



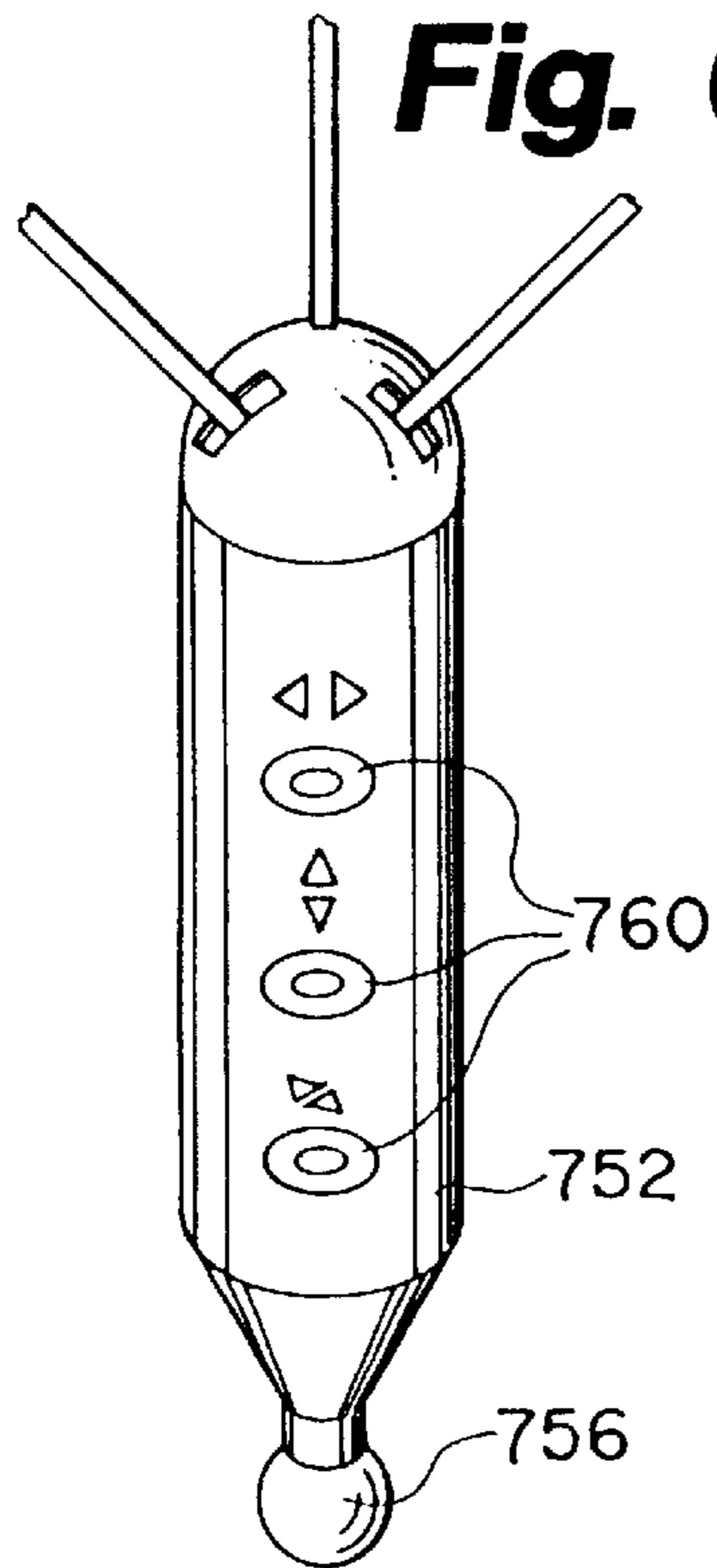




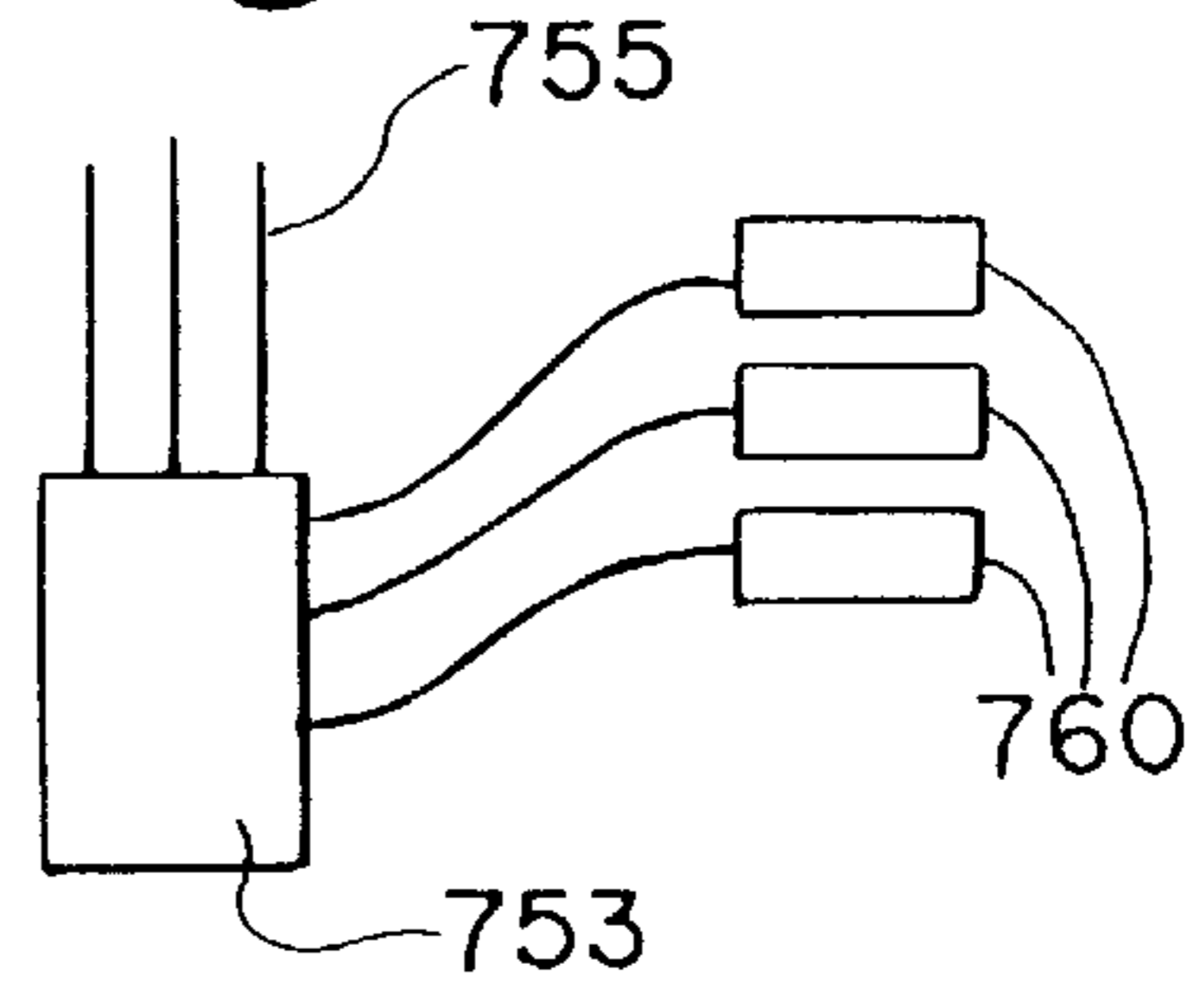
**Fig. 59**

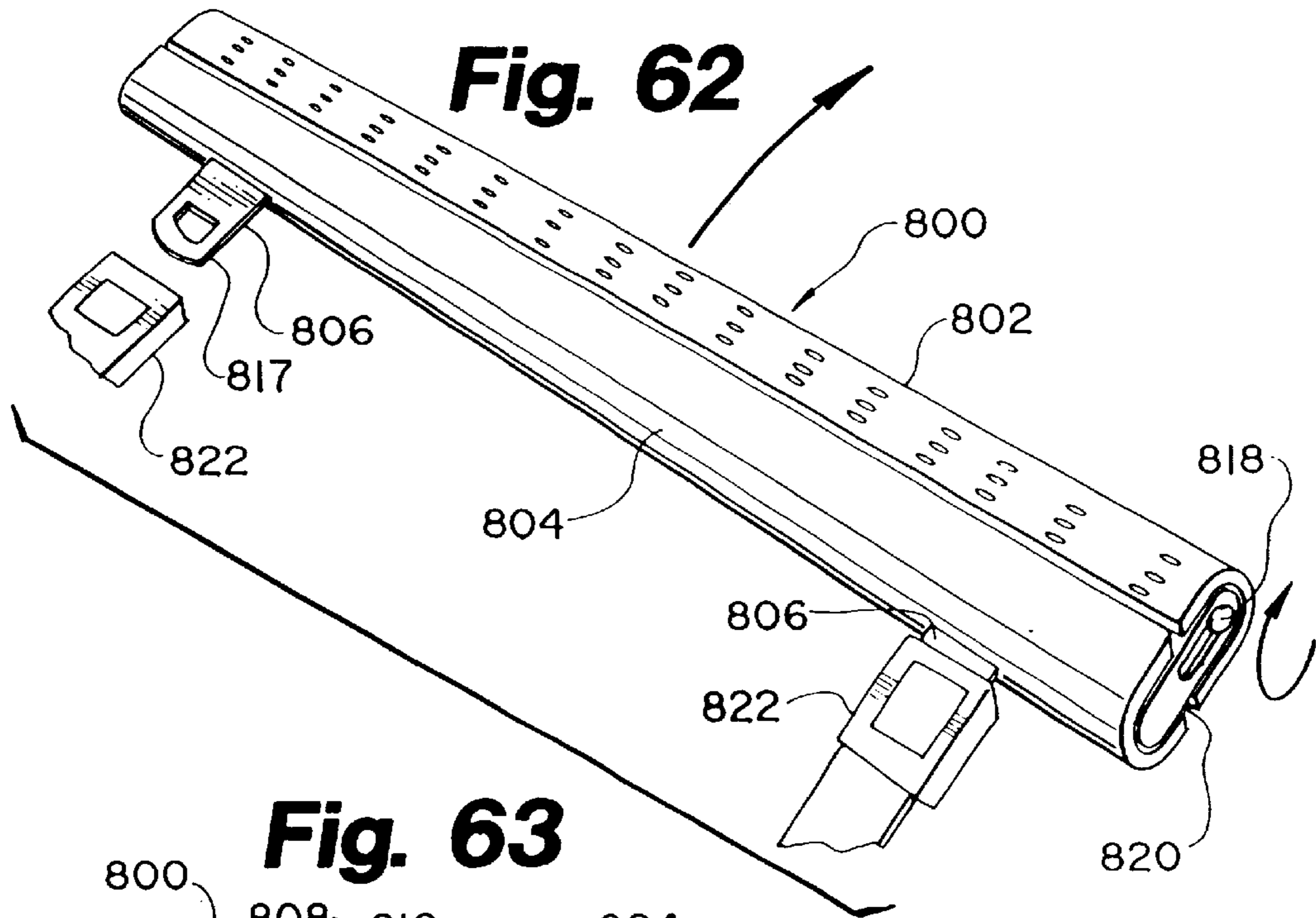


**Fig. 60**

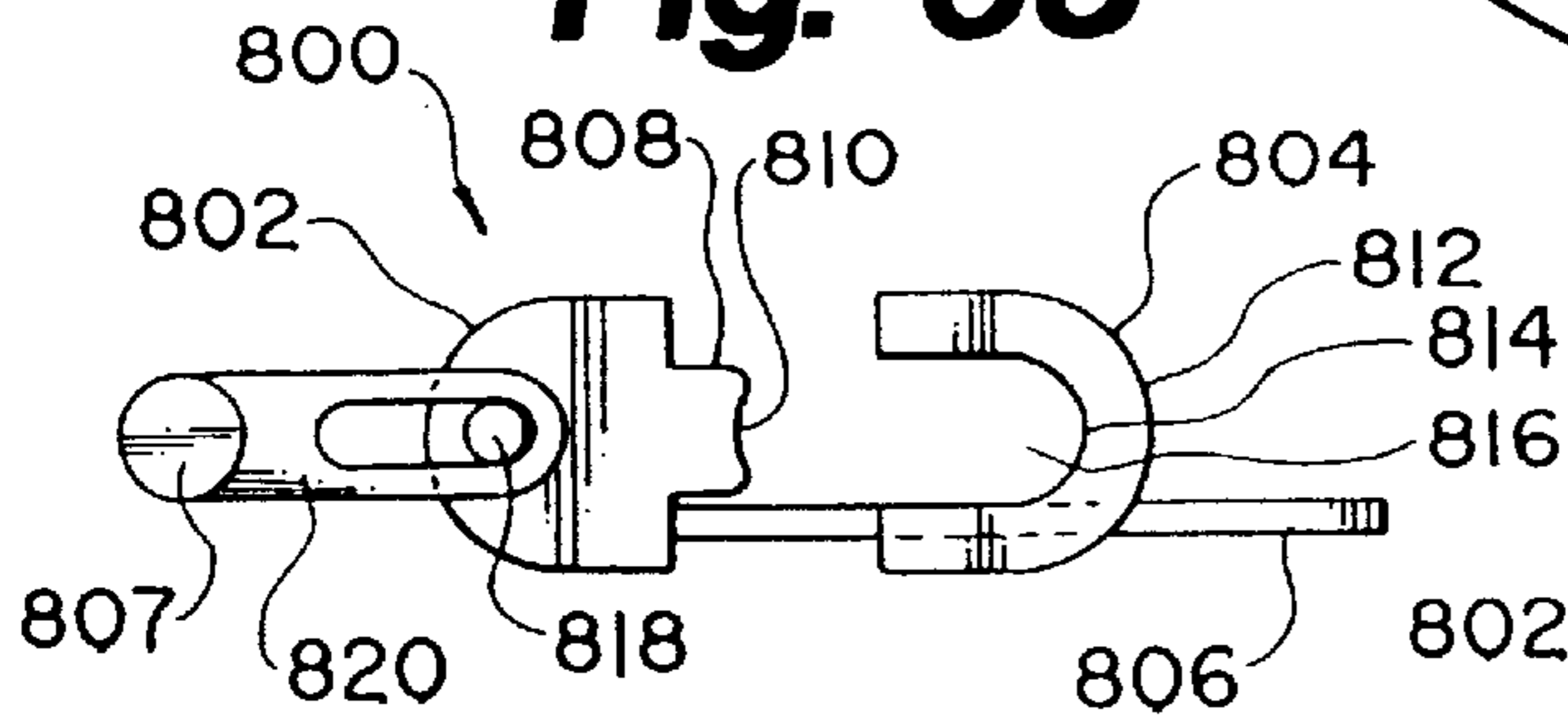


**Fig. 61**

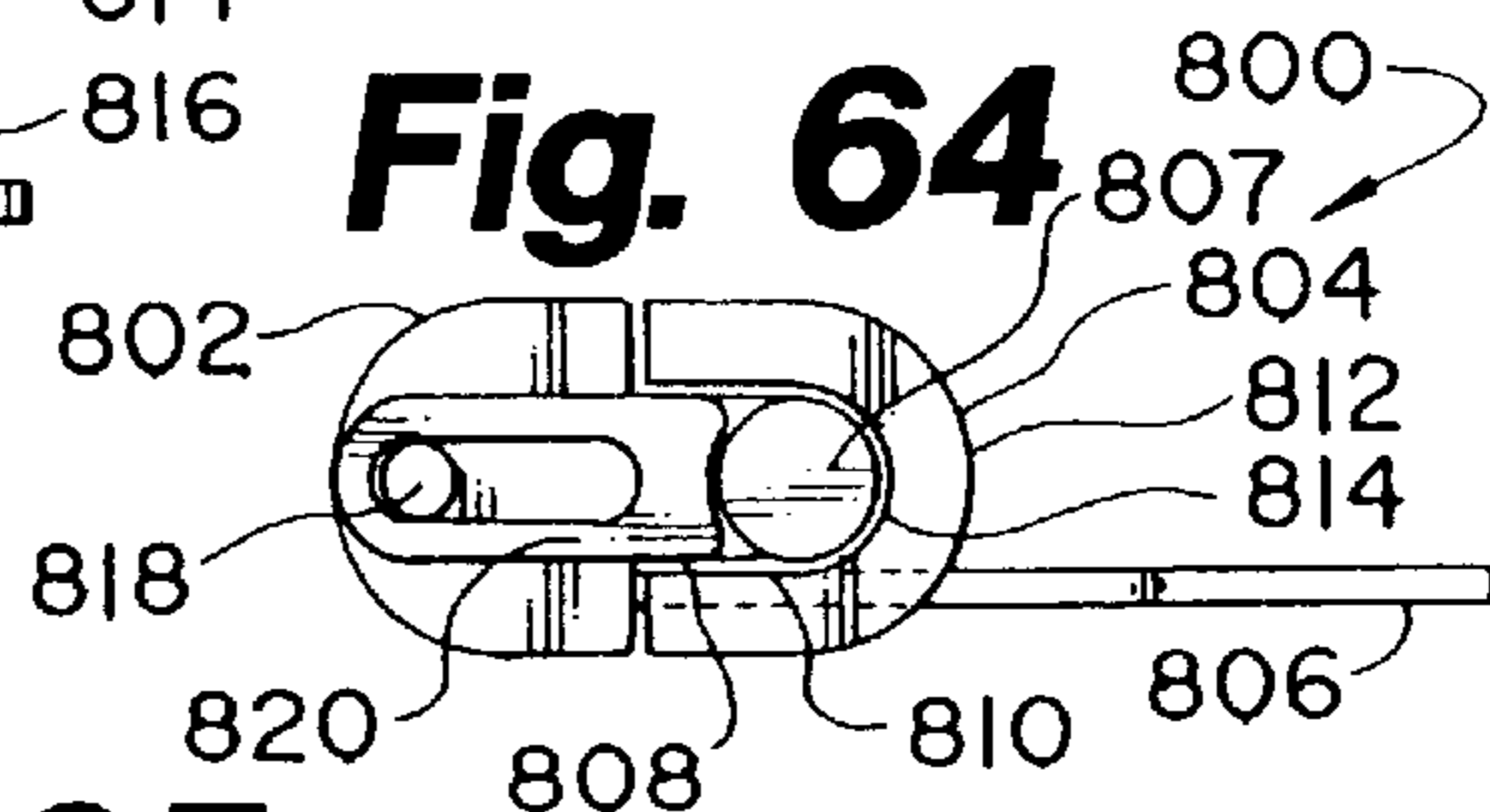




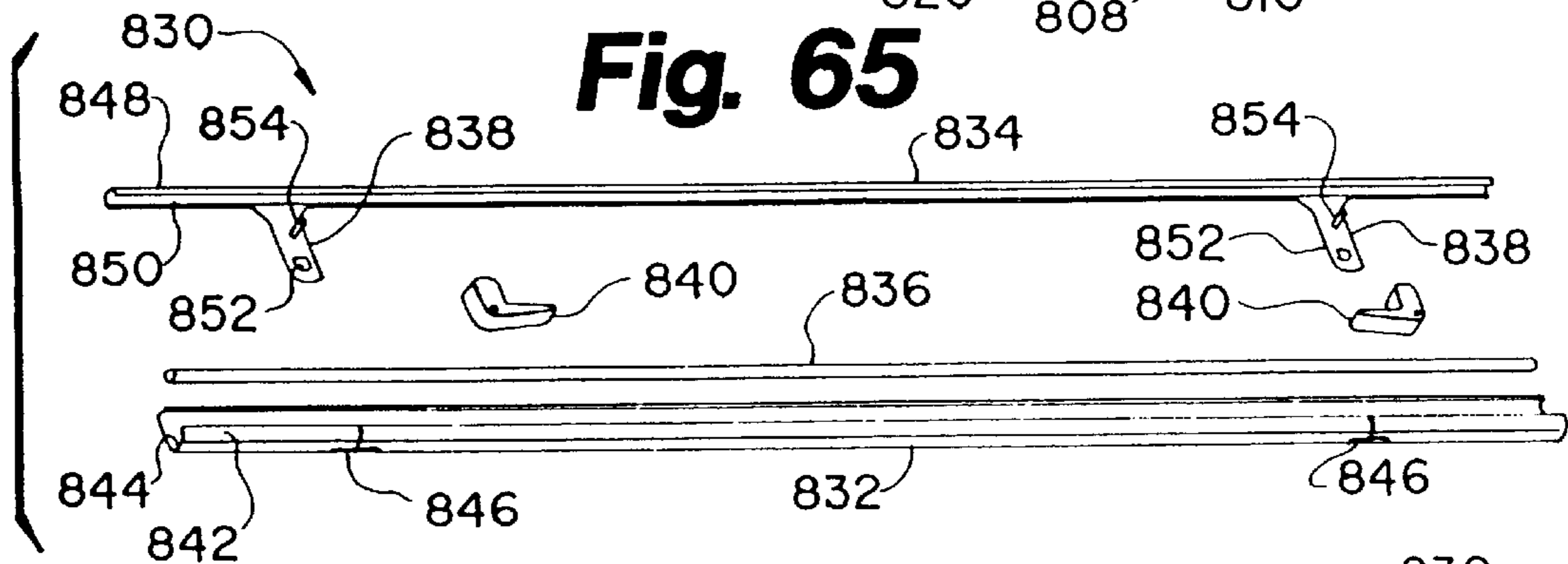
**Fig. 63**



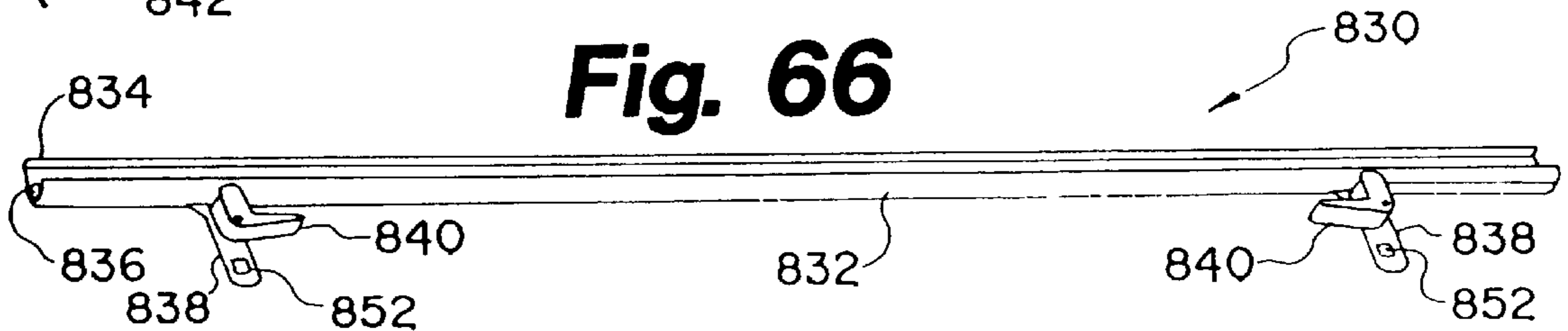
**Fig. 64**



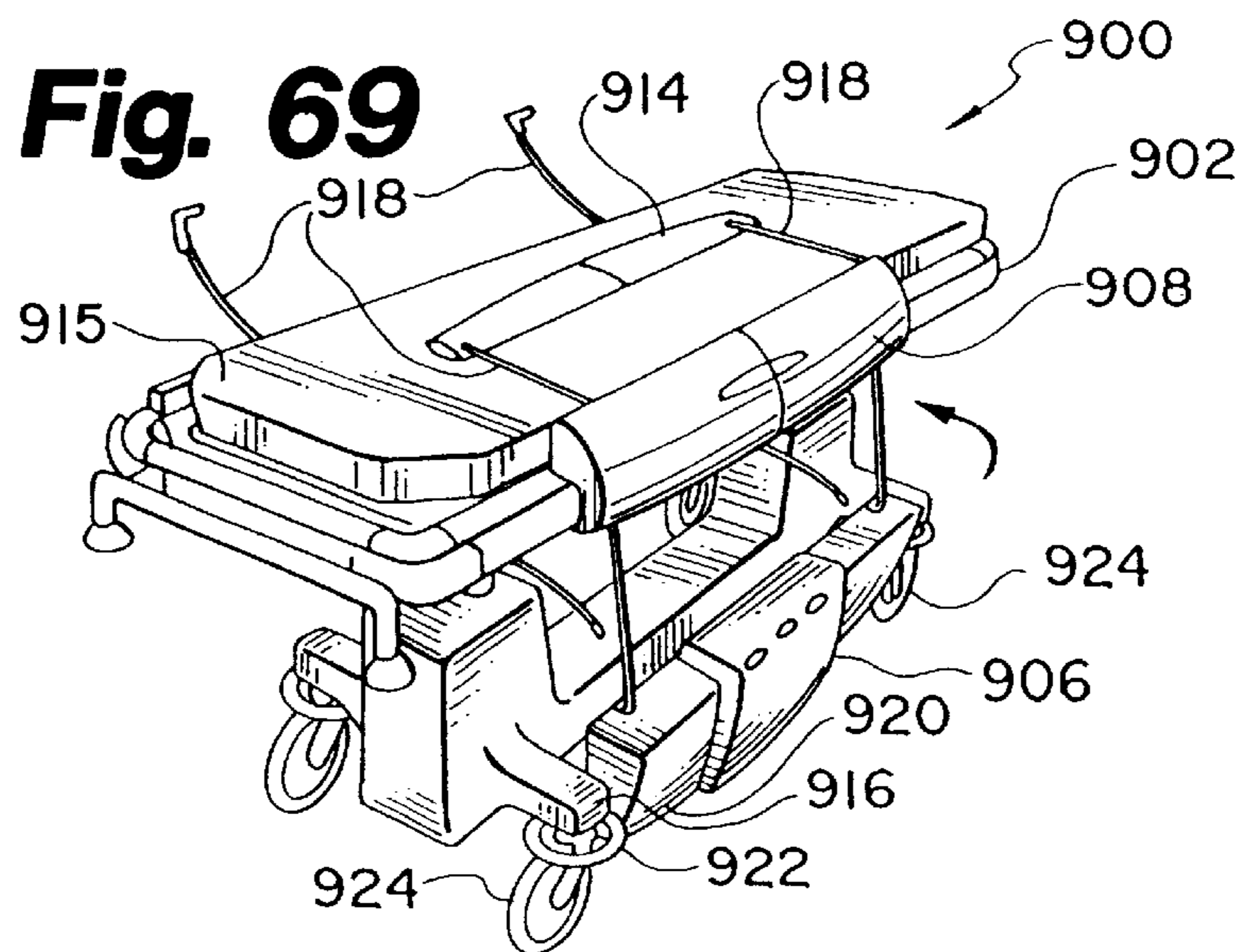
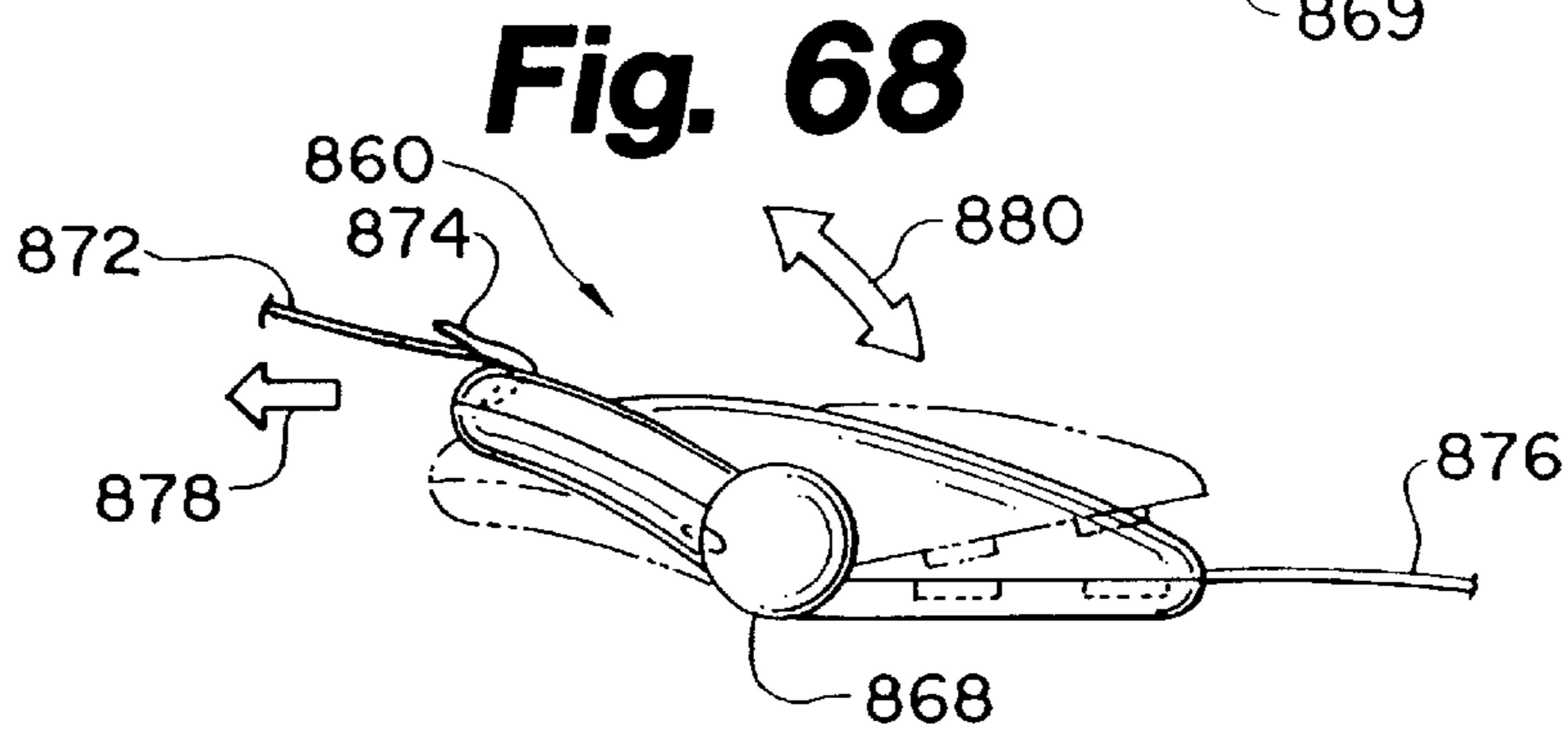
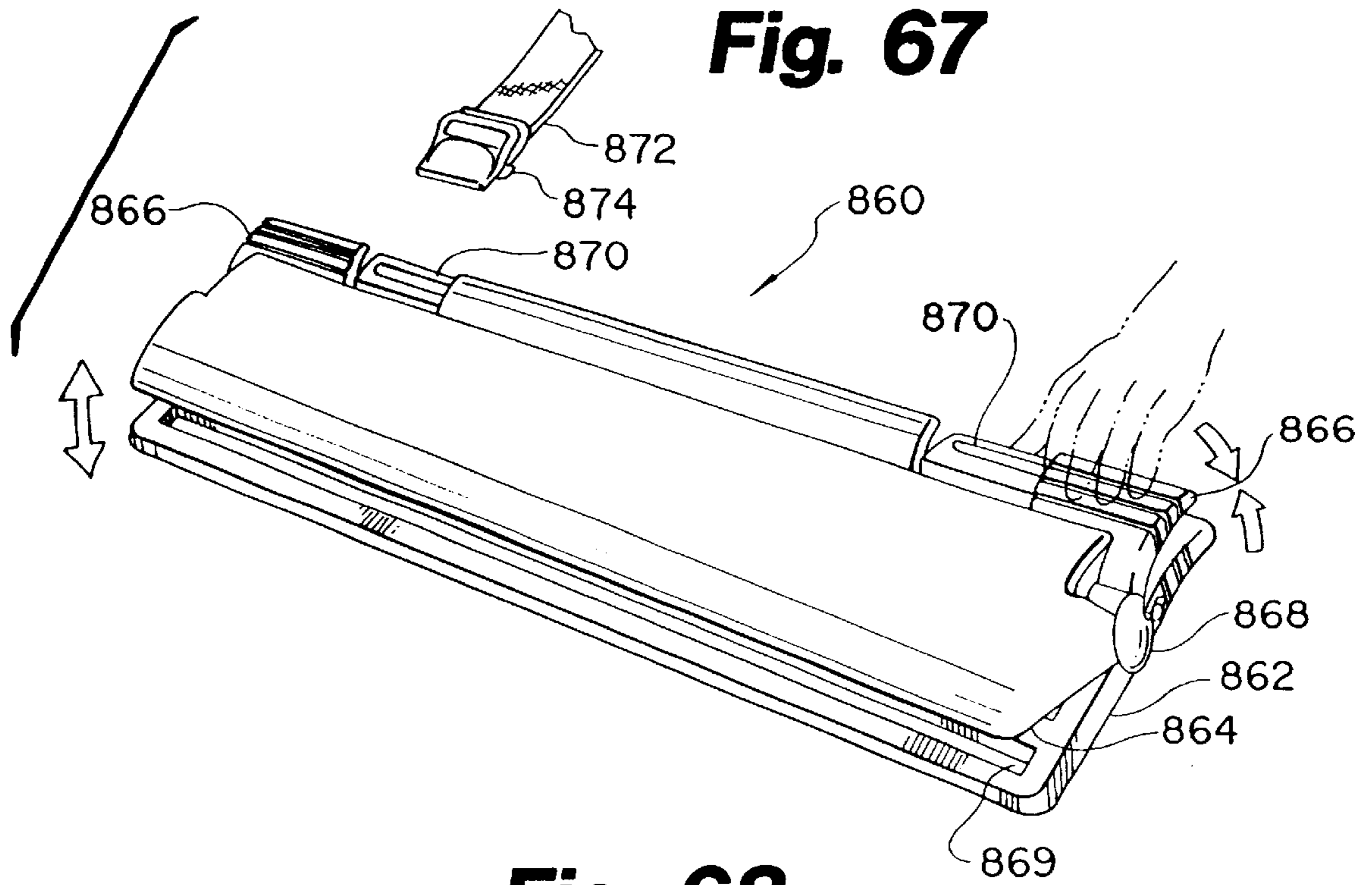
**Fig. 65**

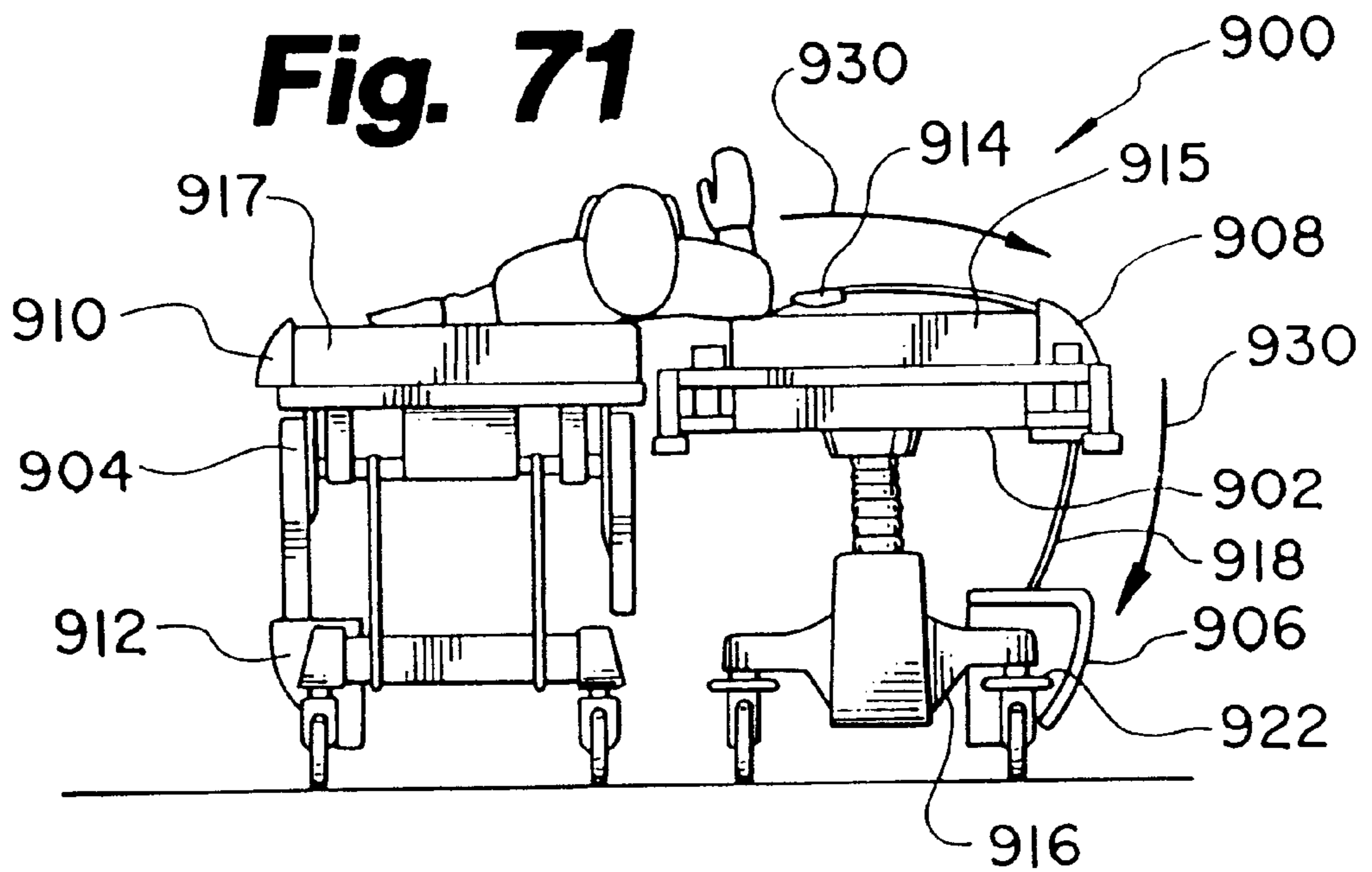
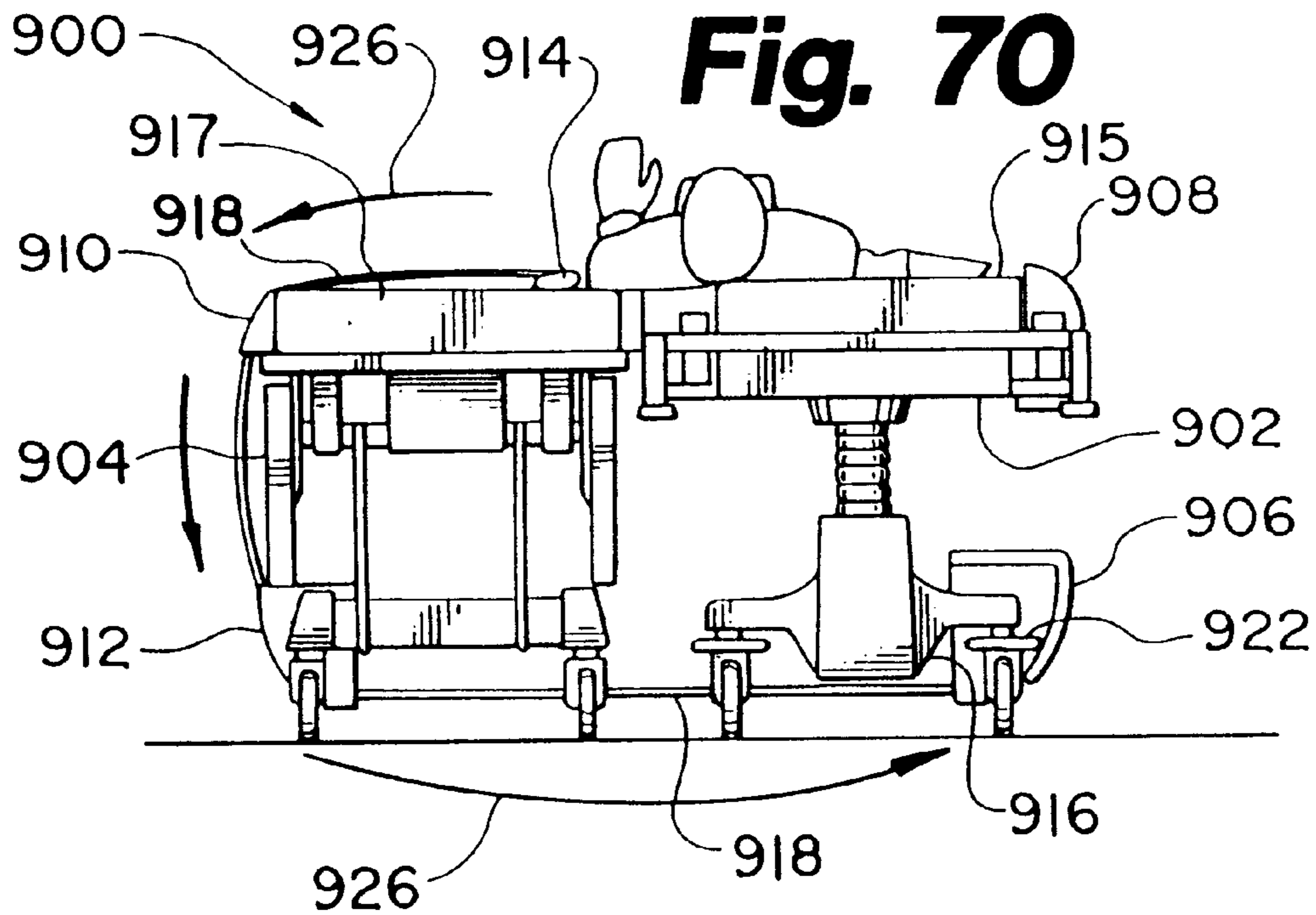


**Fig. 66**

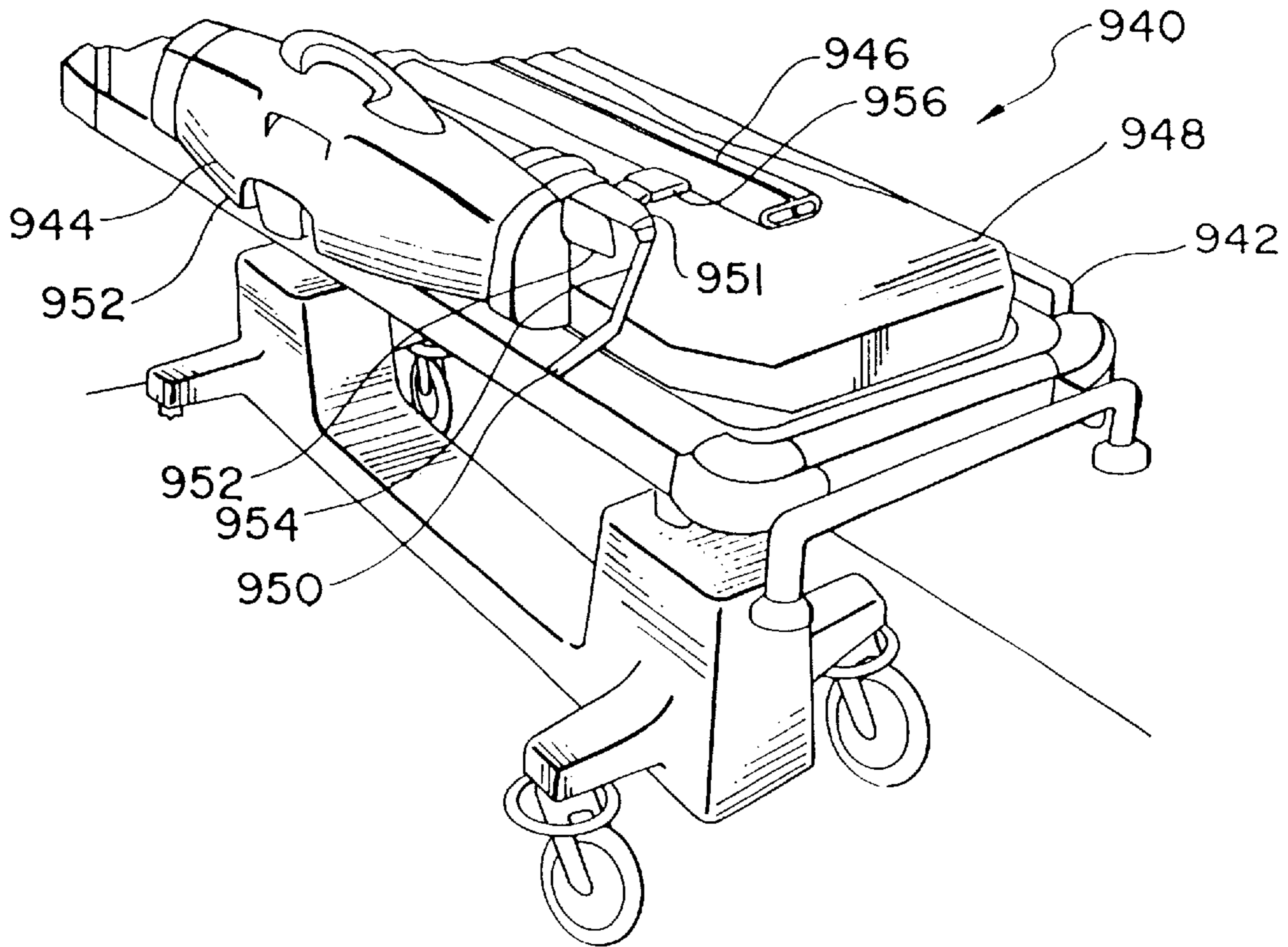




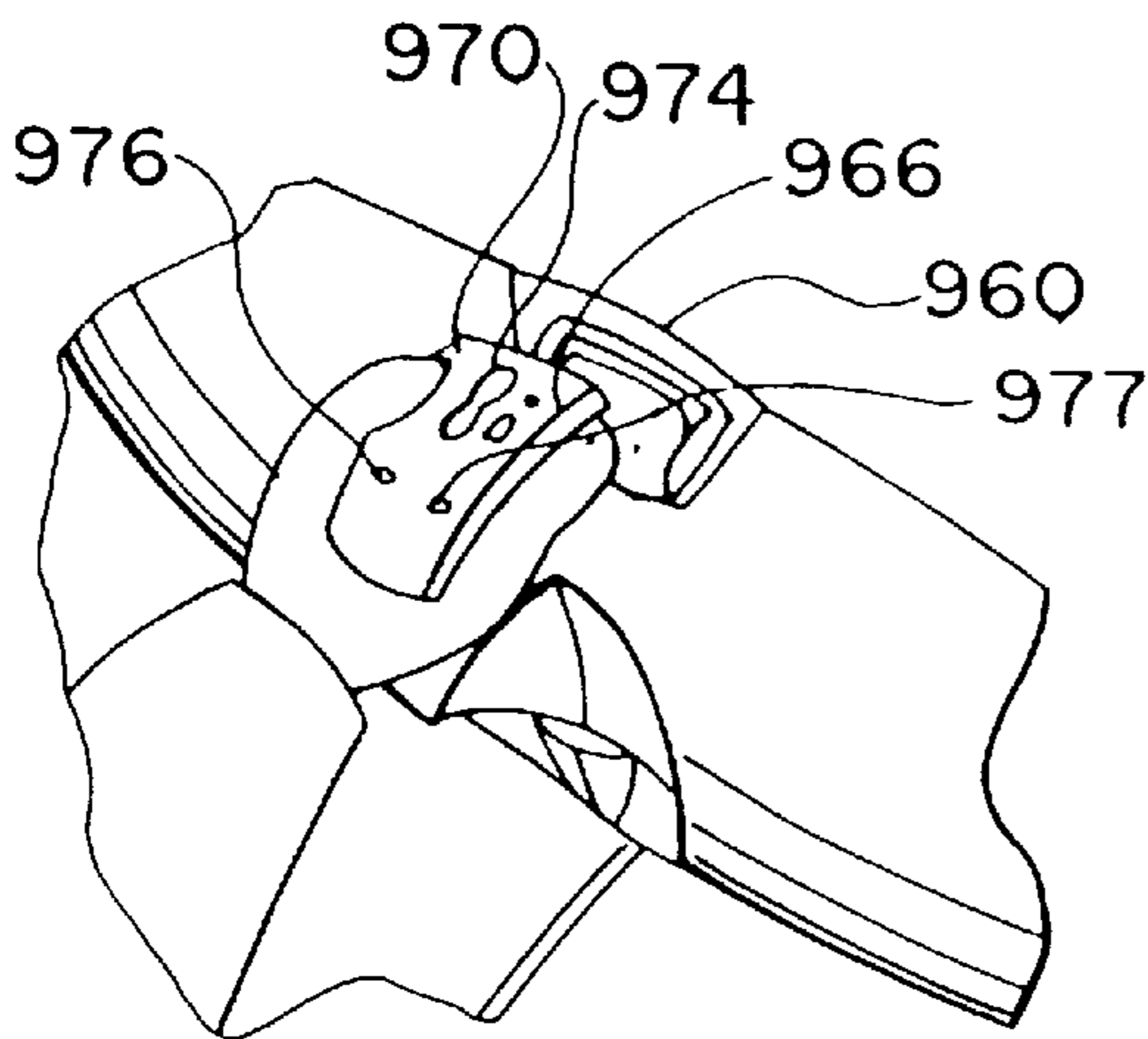




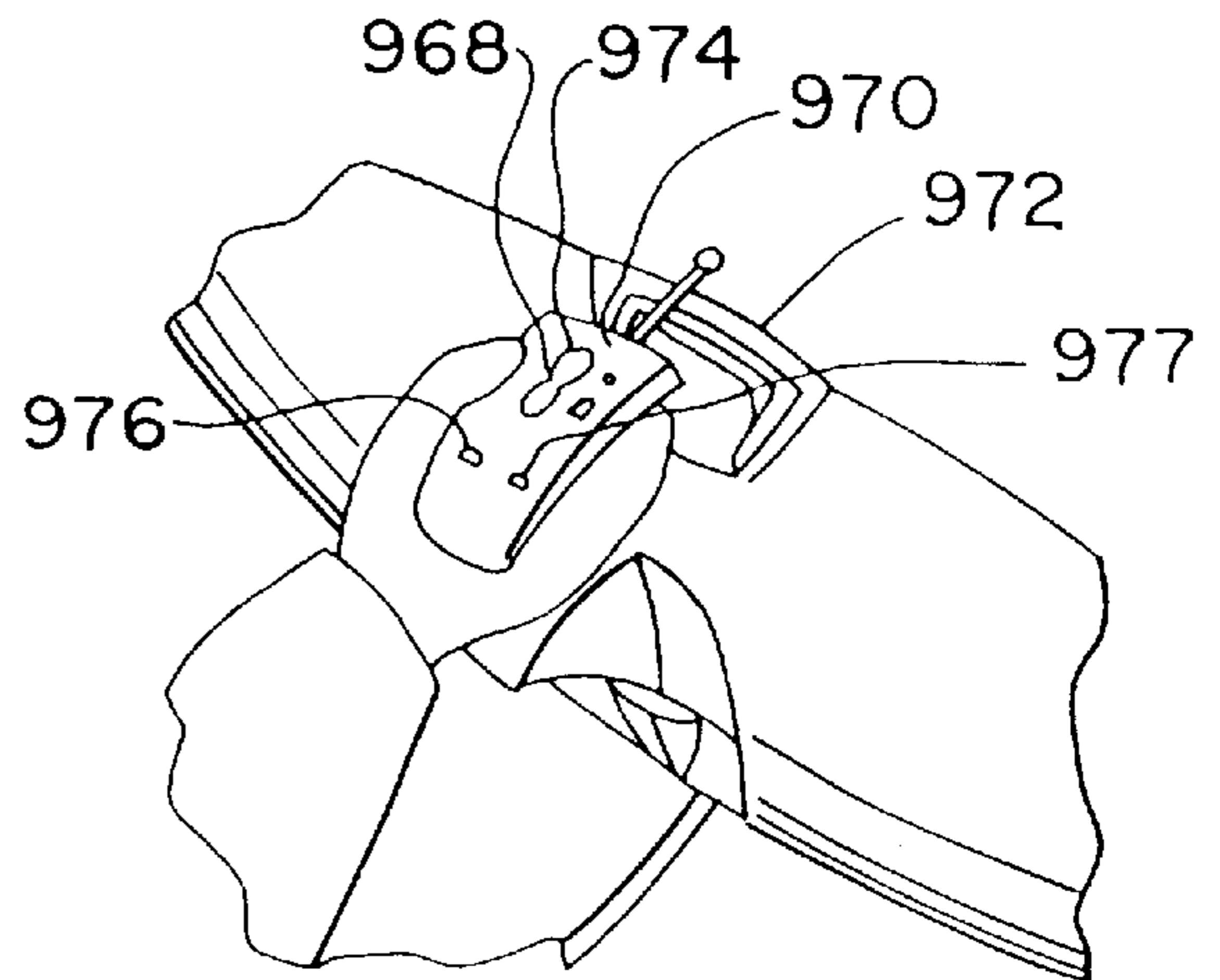
**Fig. 72**



**Fig. 73**

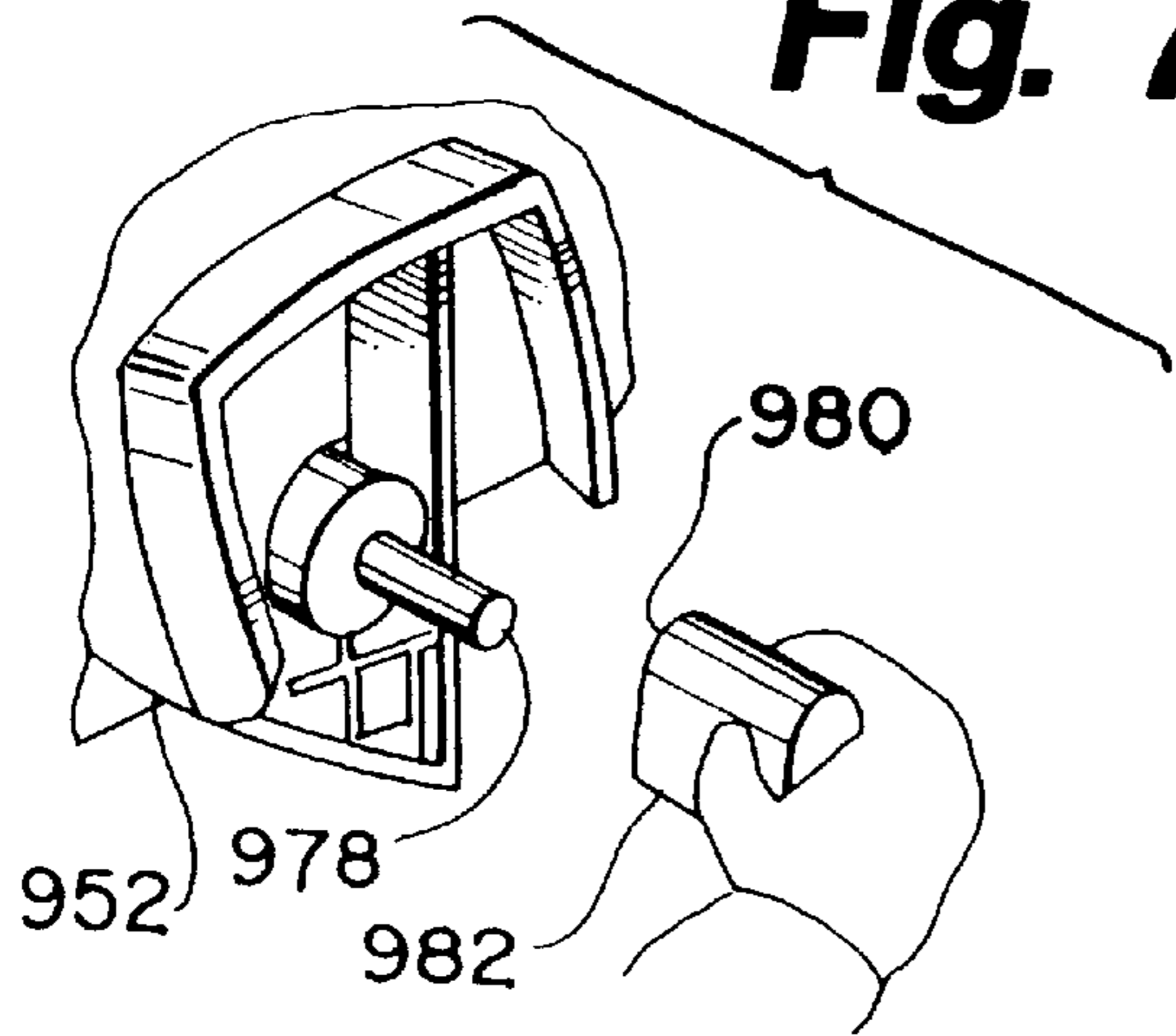


**Fig. 74**

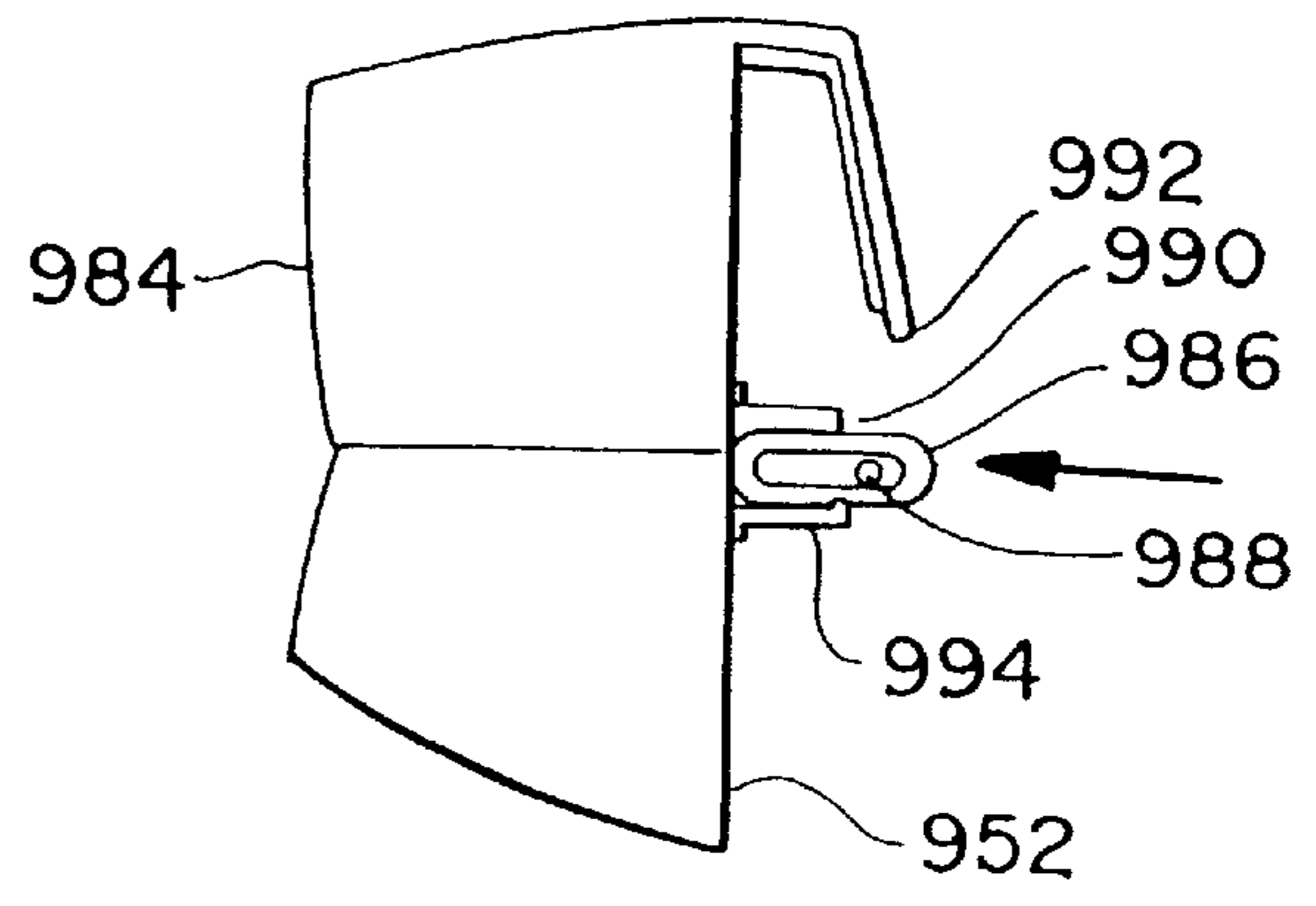




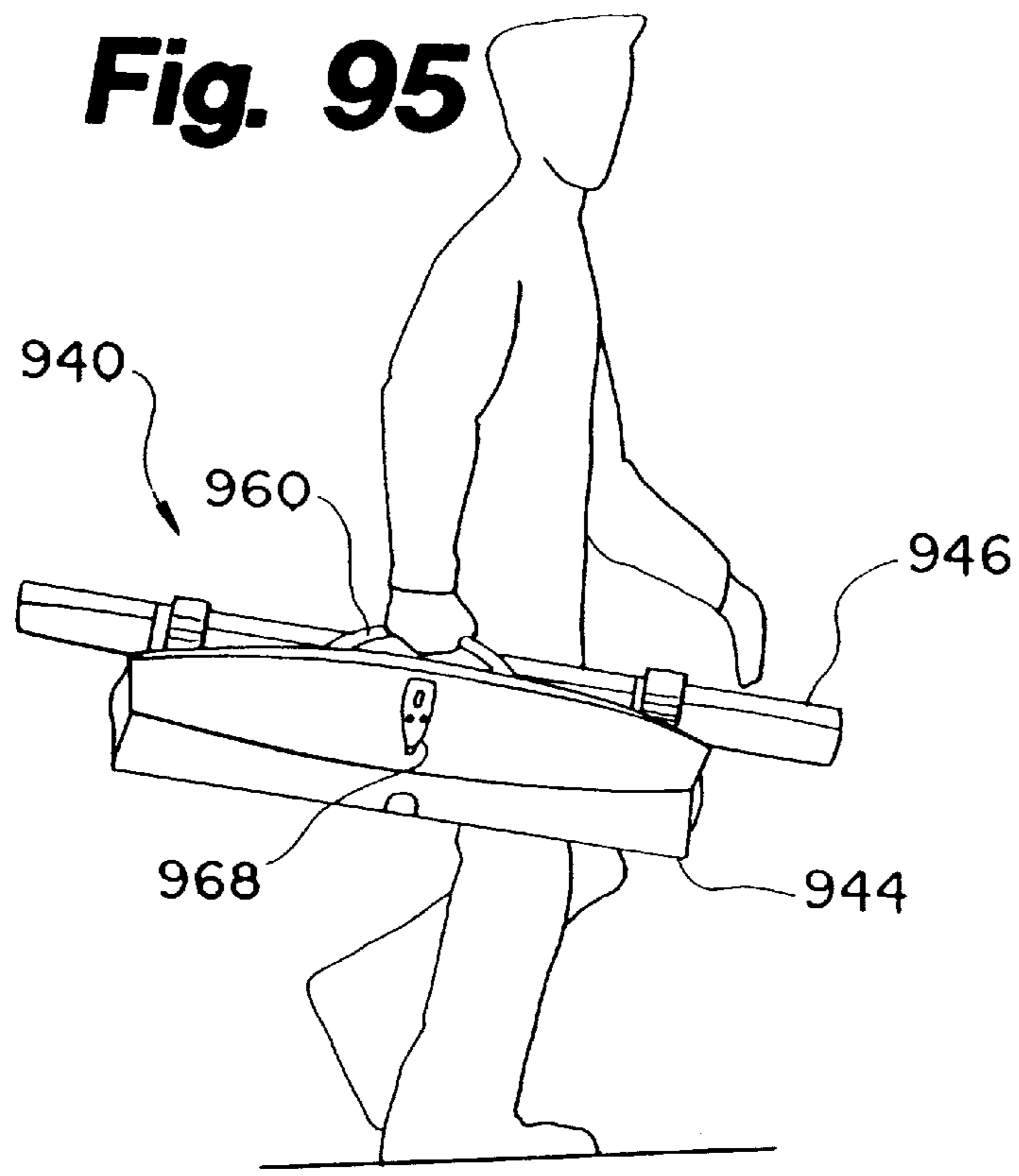
**Fig. 75**

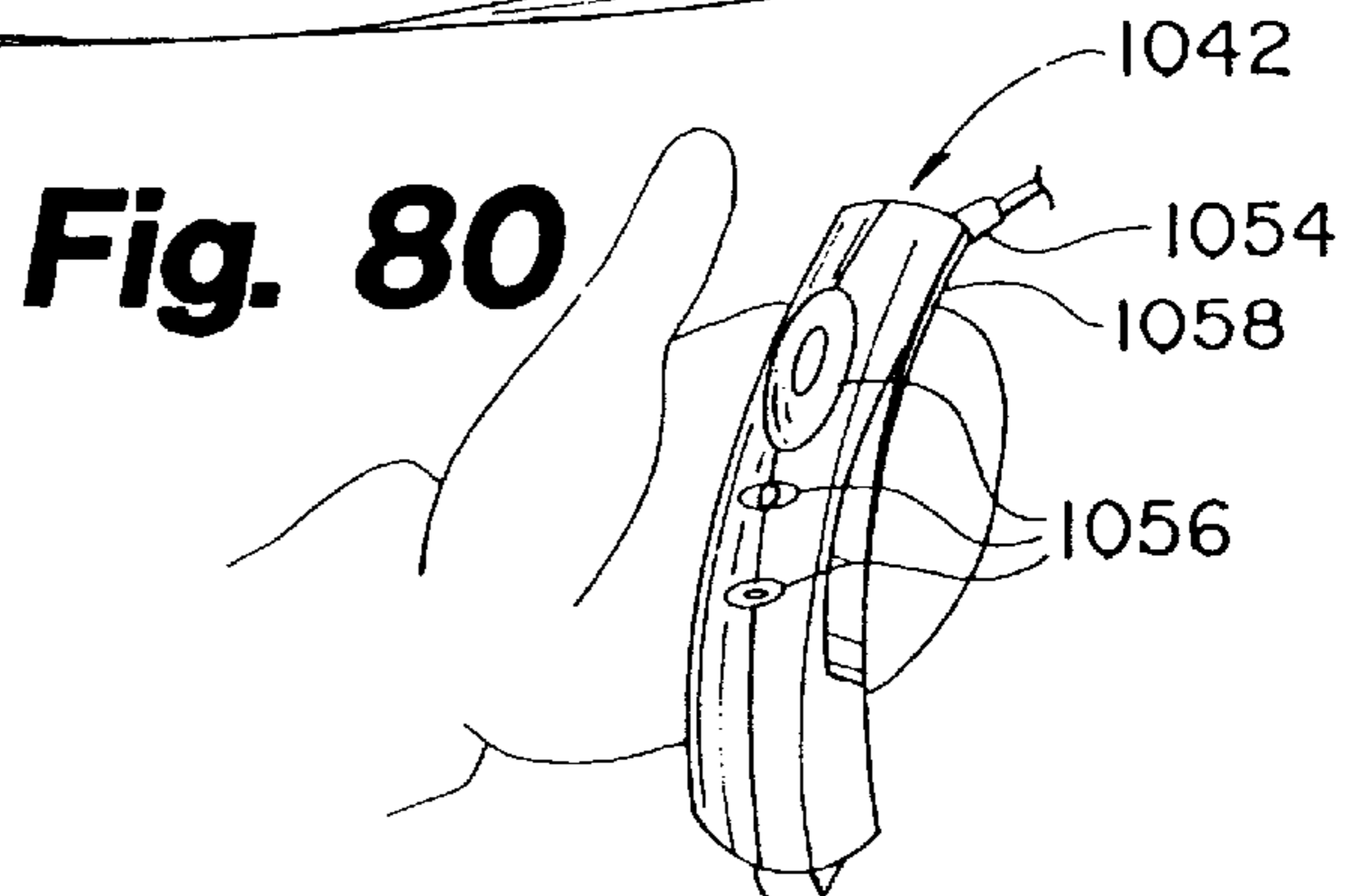
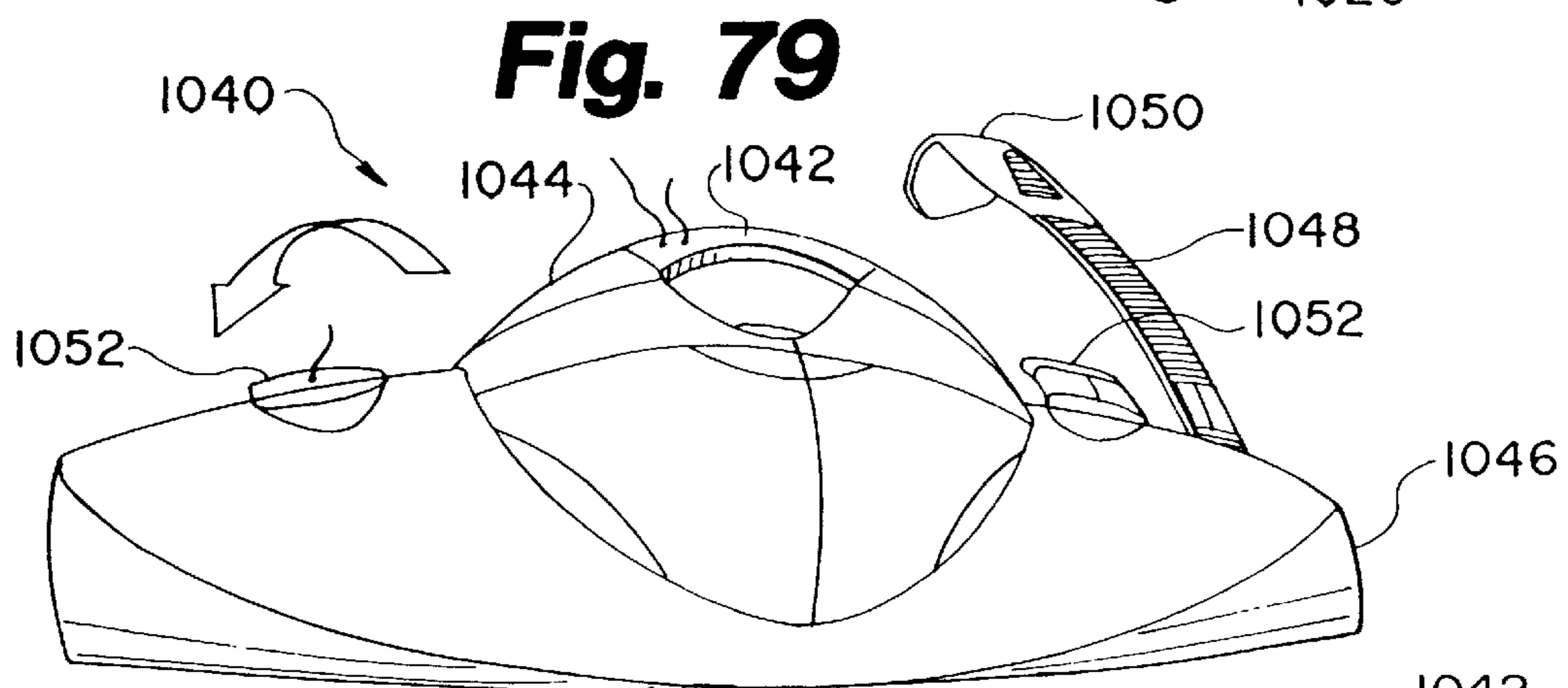
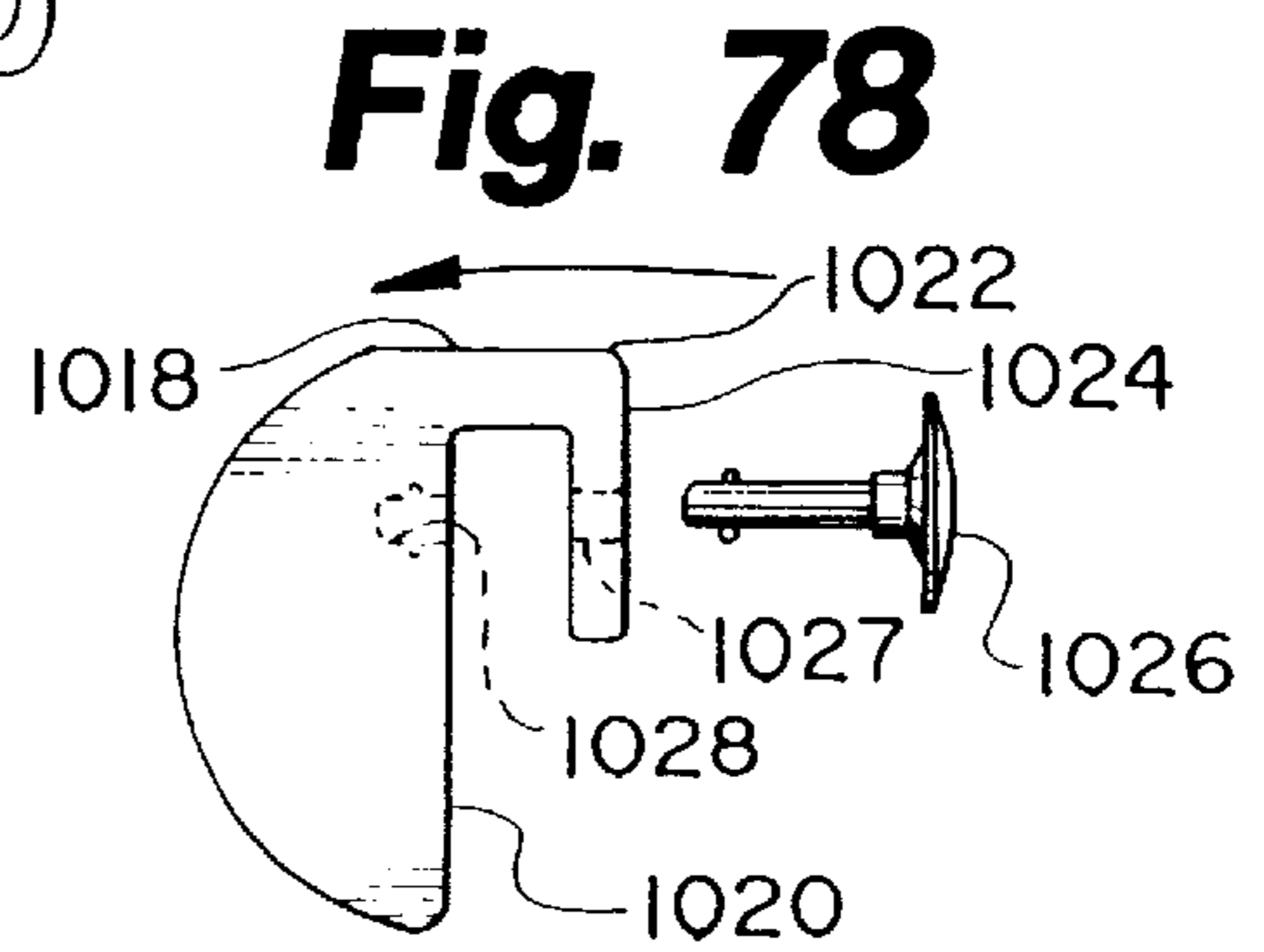
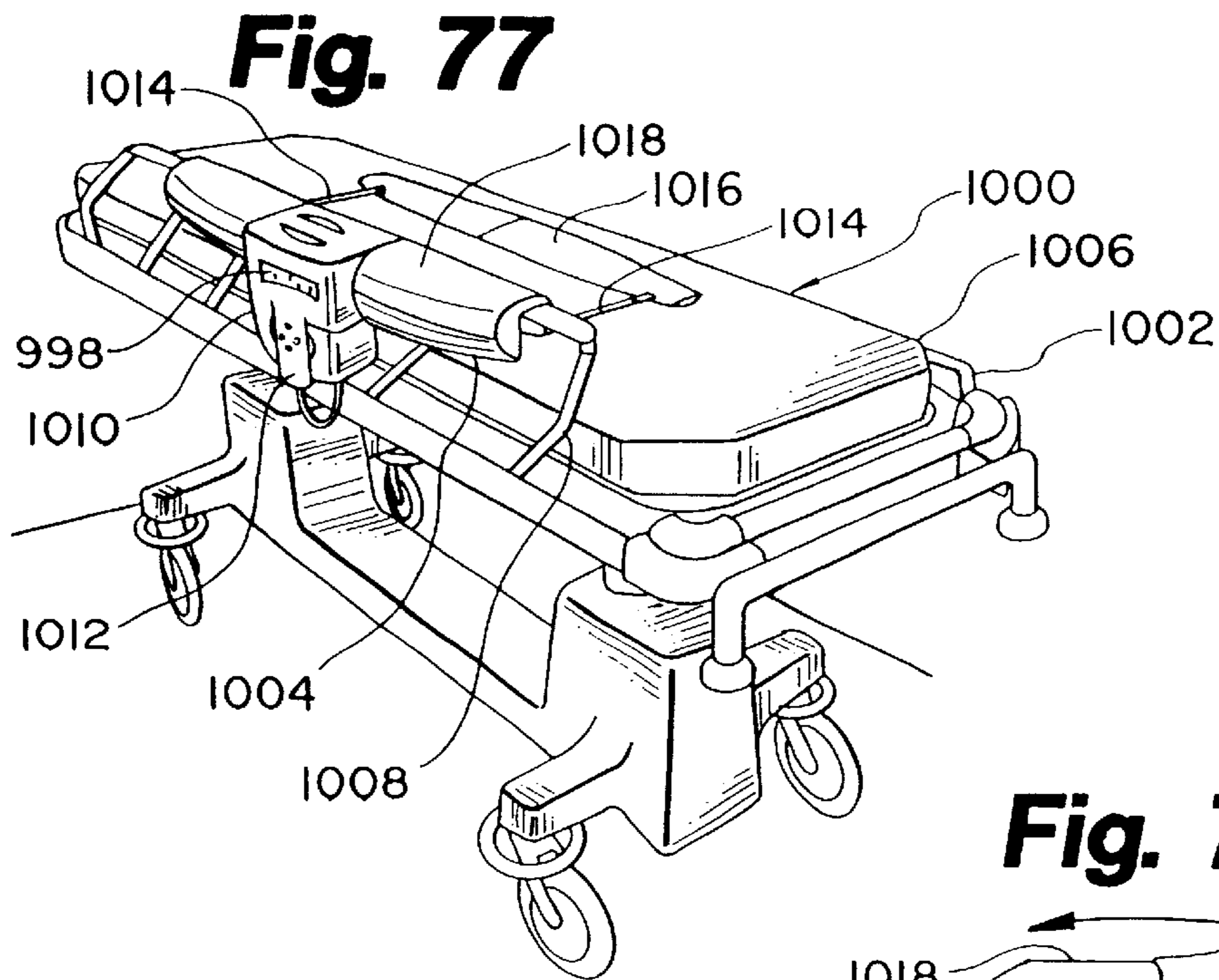


**Fig. 76**

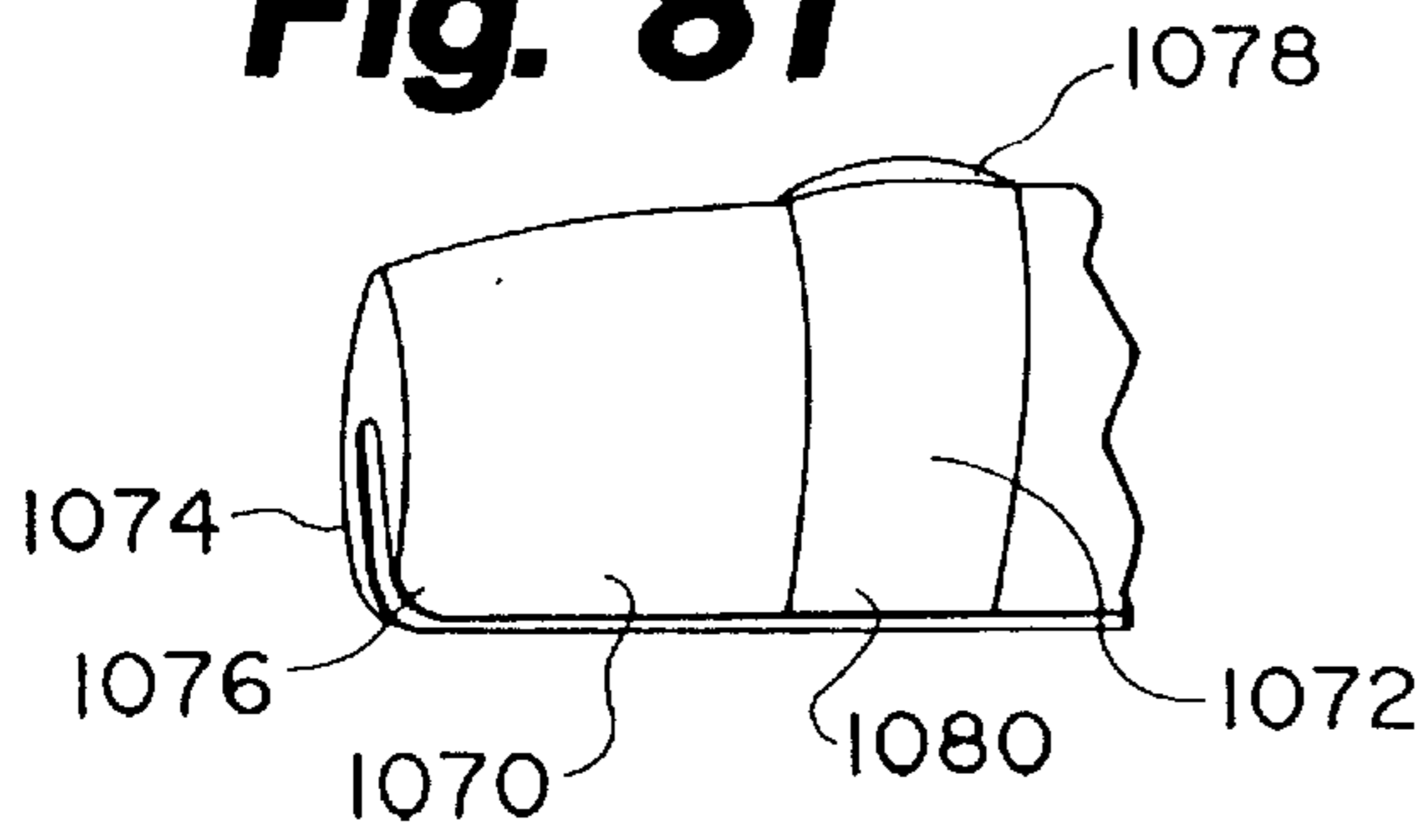


**Fig. 95**

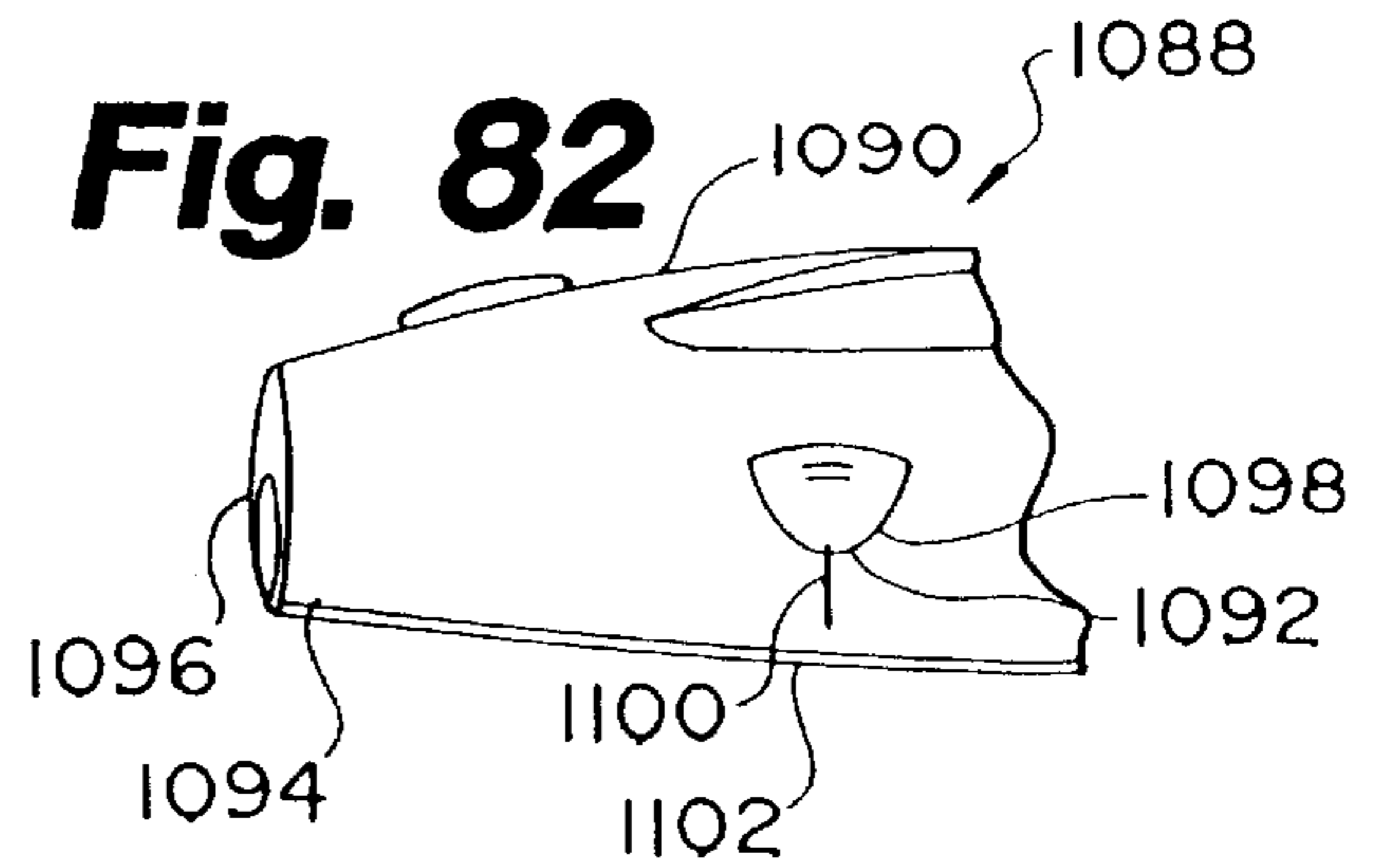




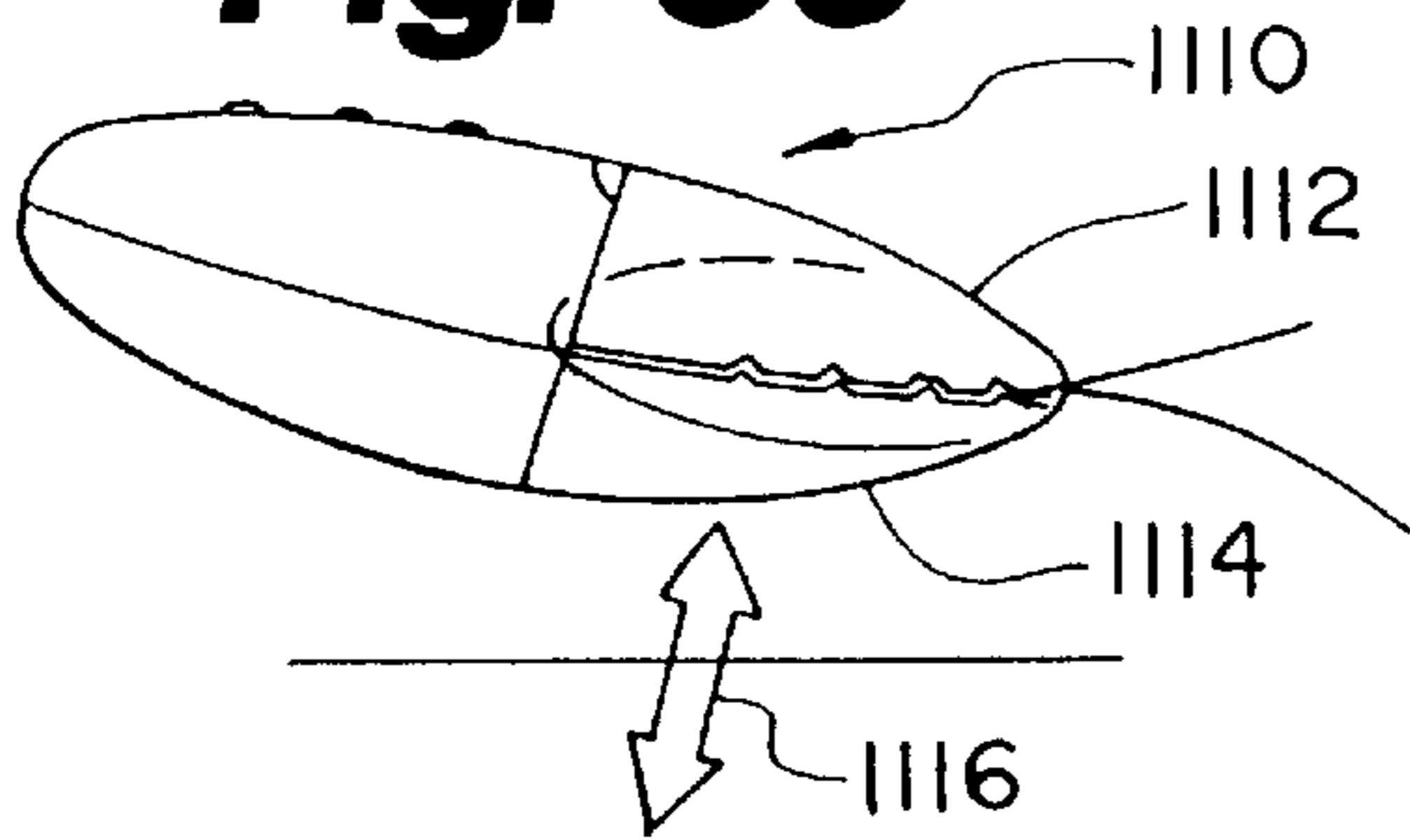
**Fig. 81**



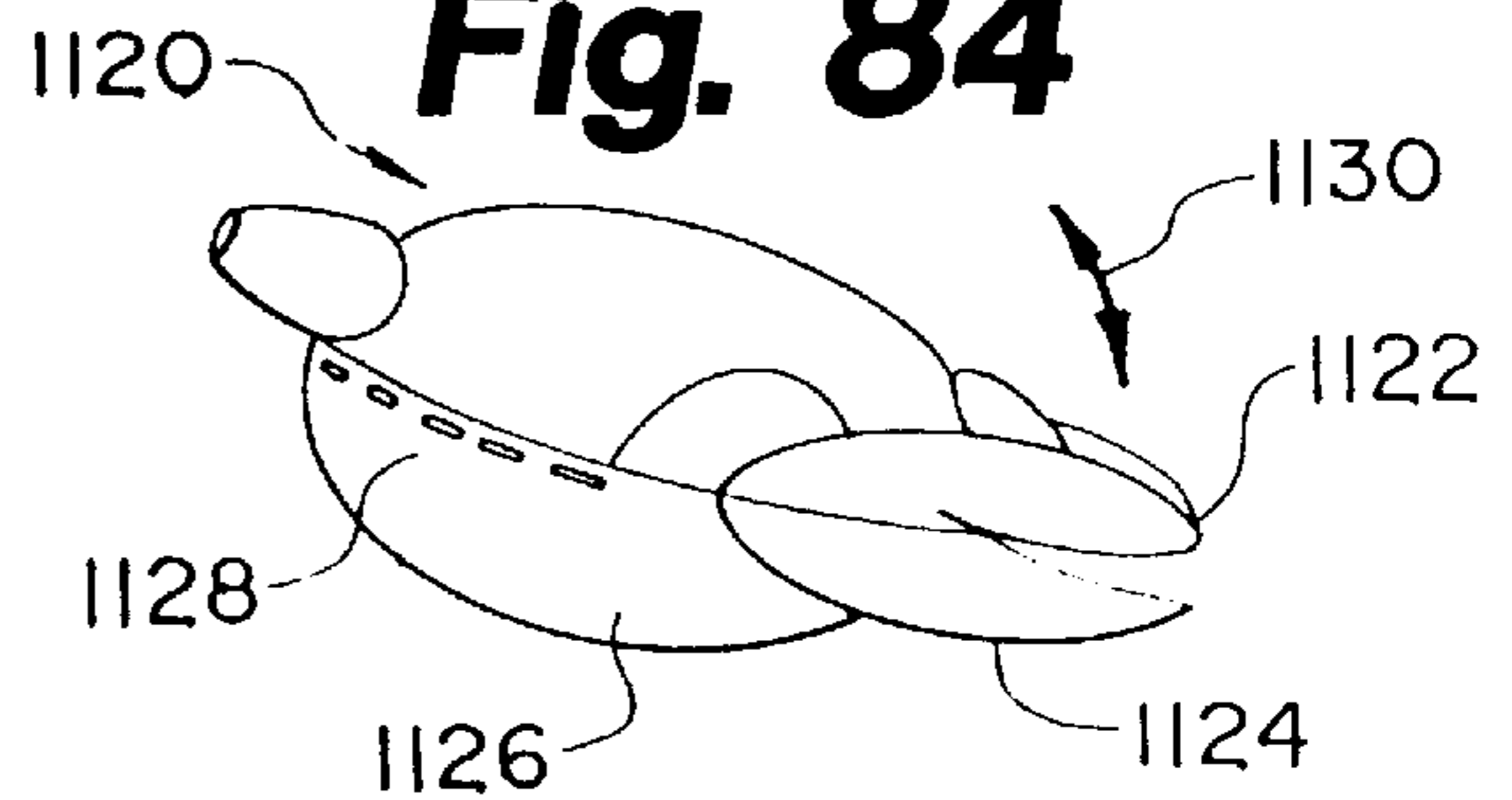
**Fig. 82**



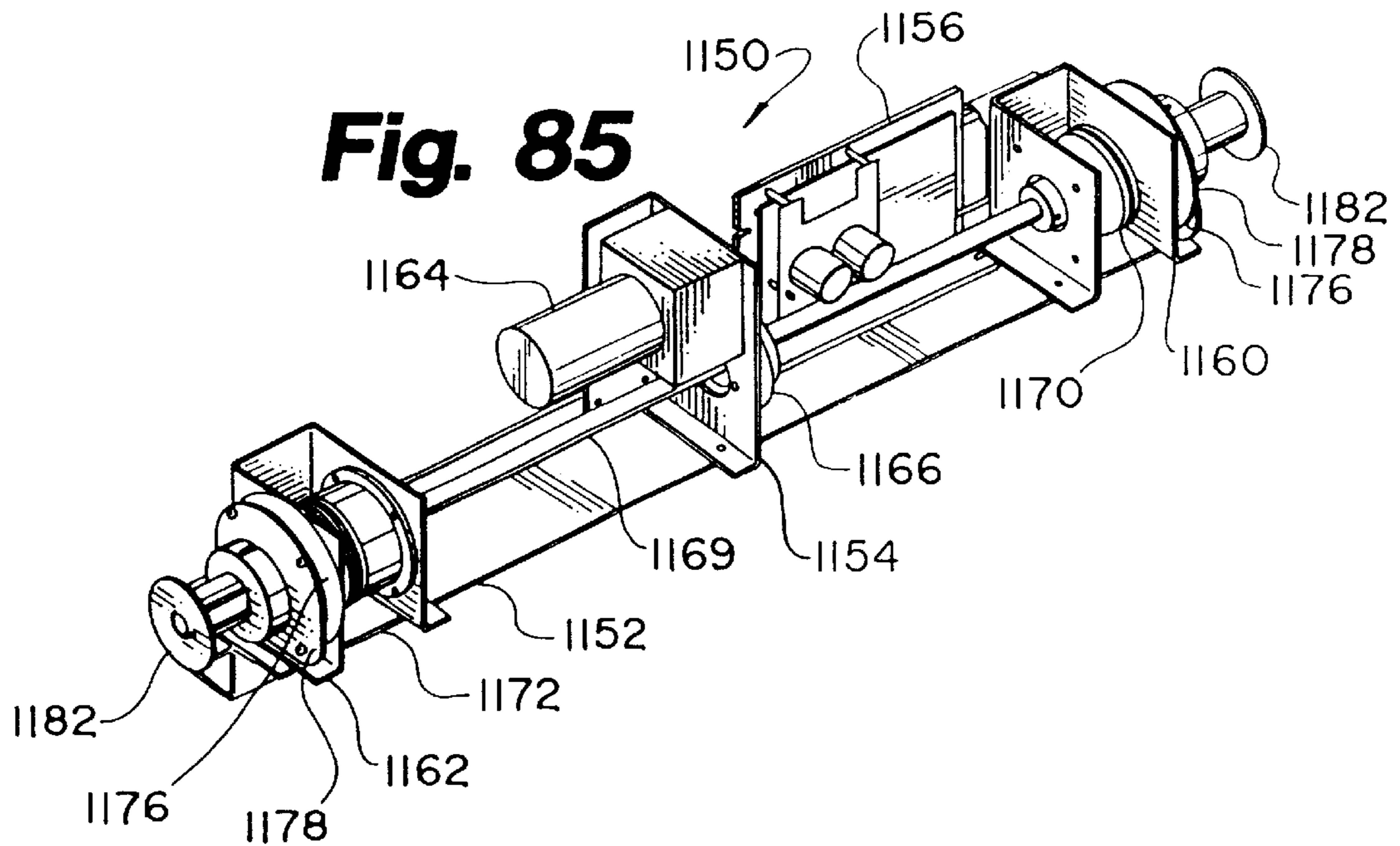
**Fig. 83**



**Fig. 84**

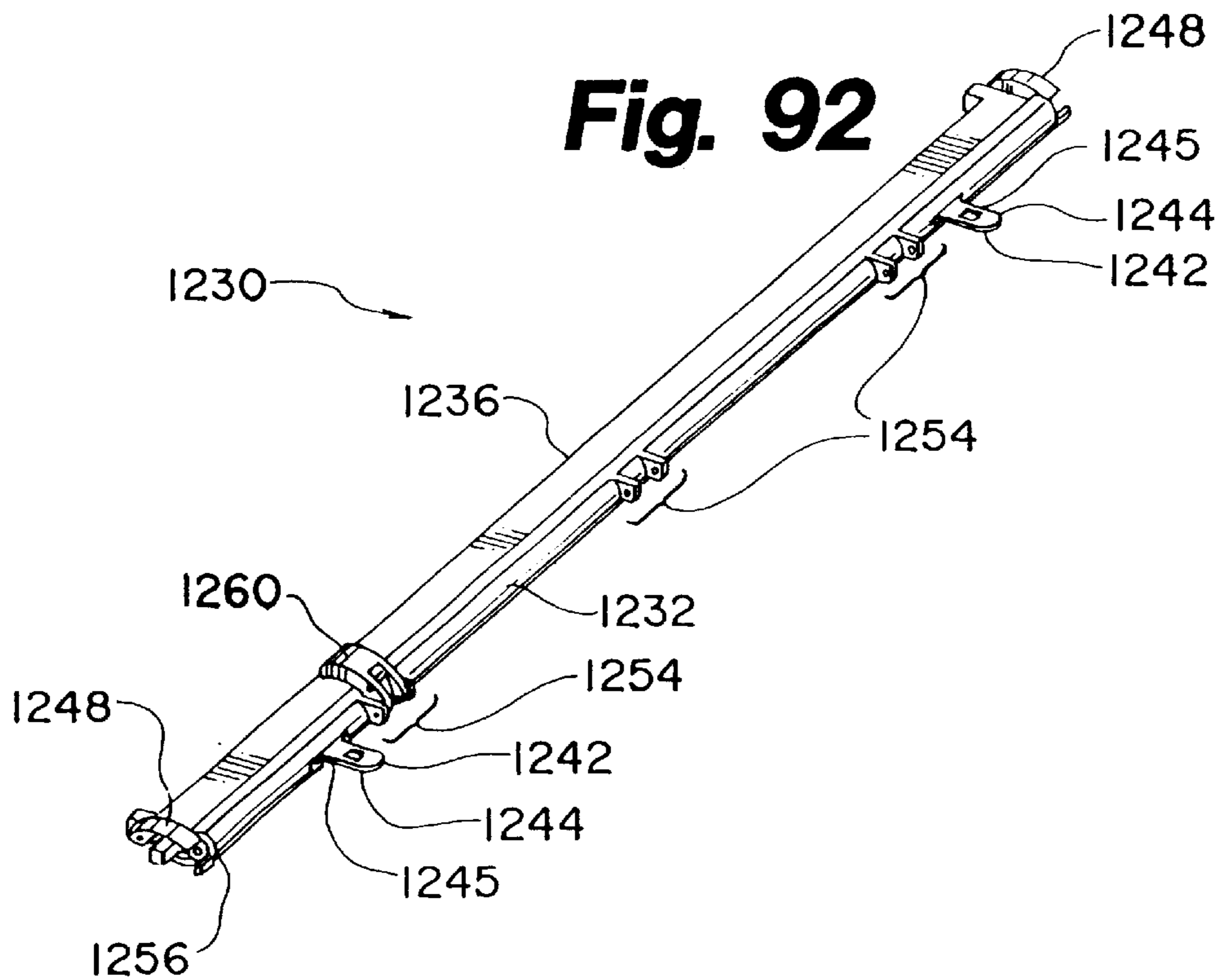
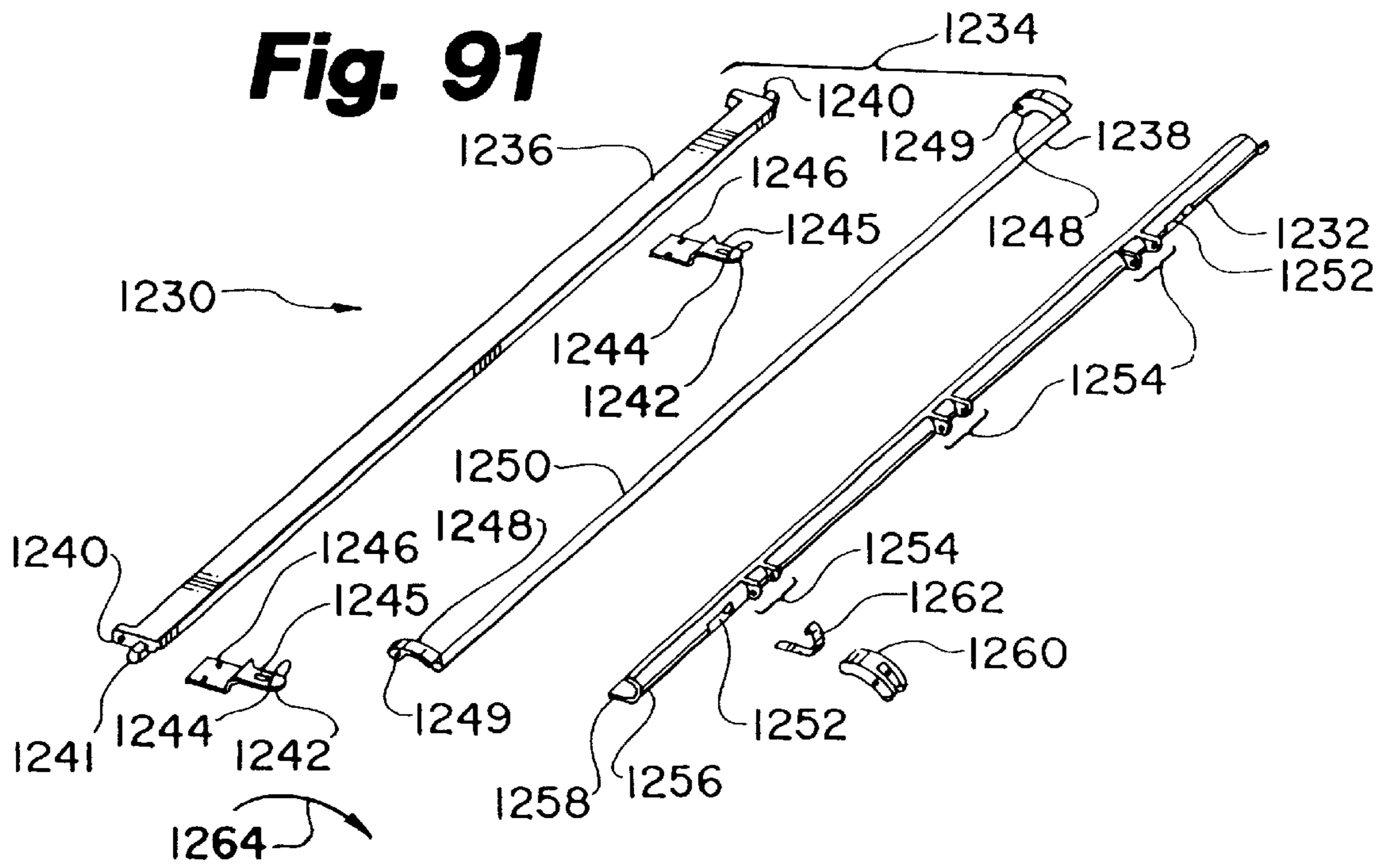


**Fig. 85**

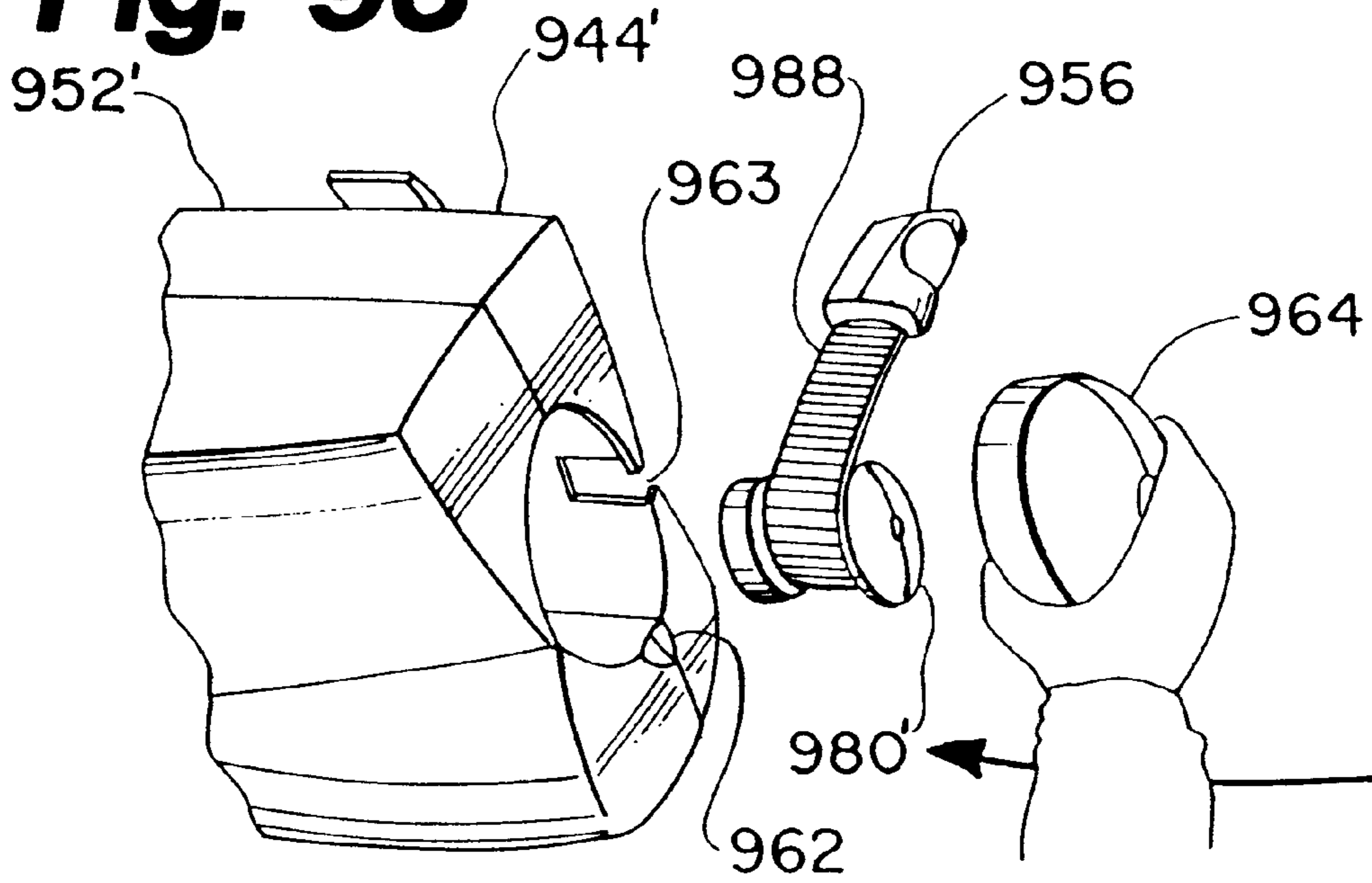








**Fig. 93**



**Fig. 94**

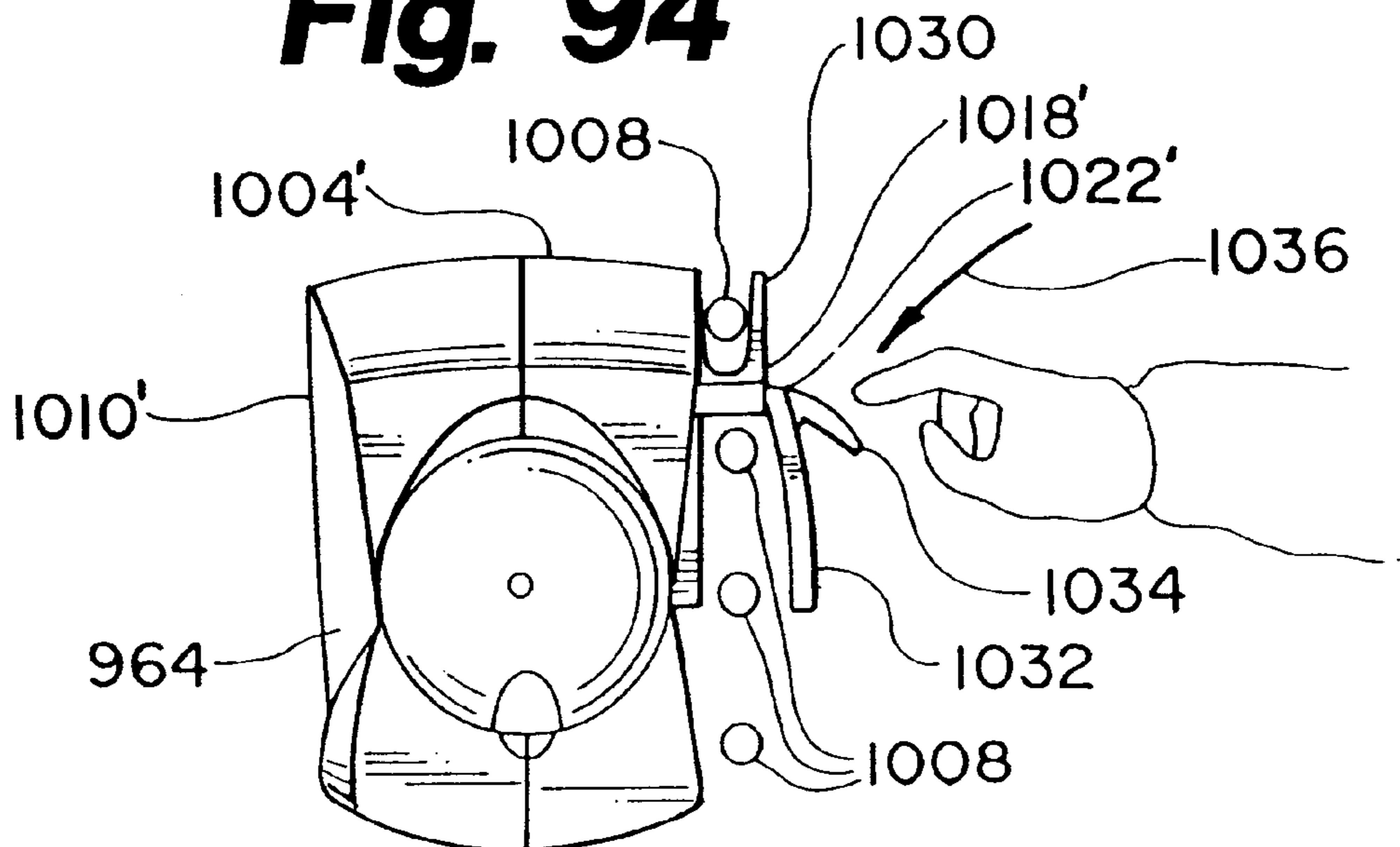




FIG. 96

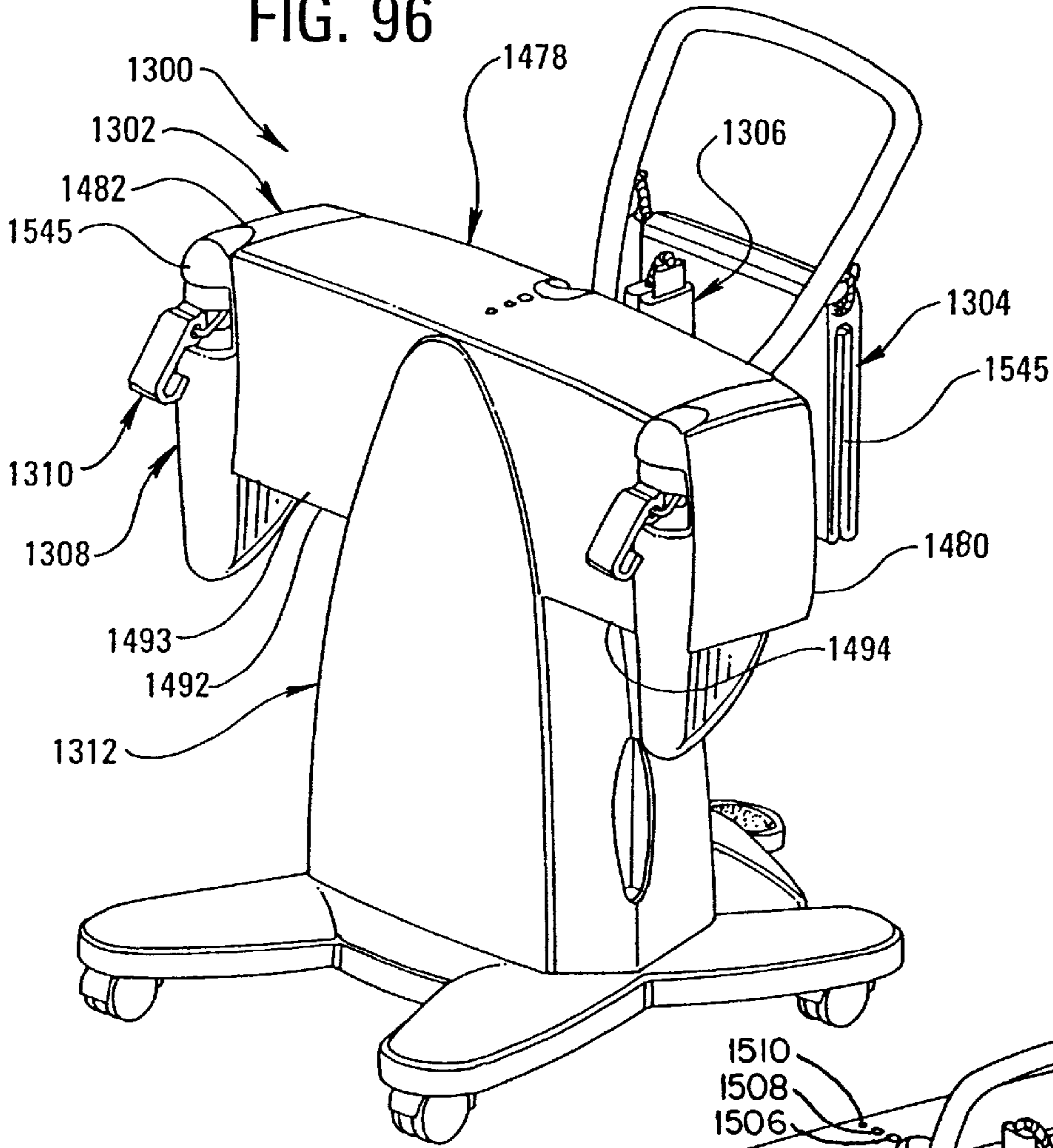
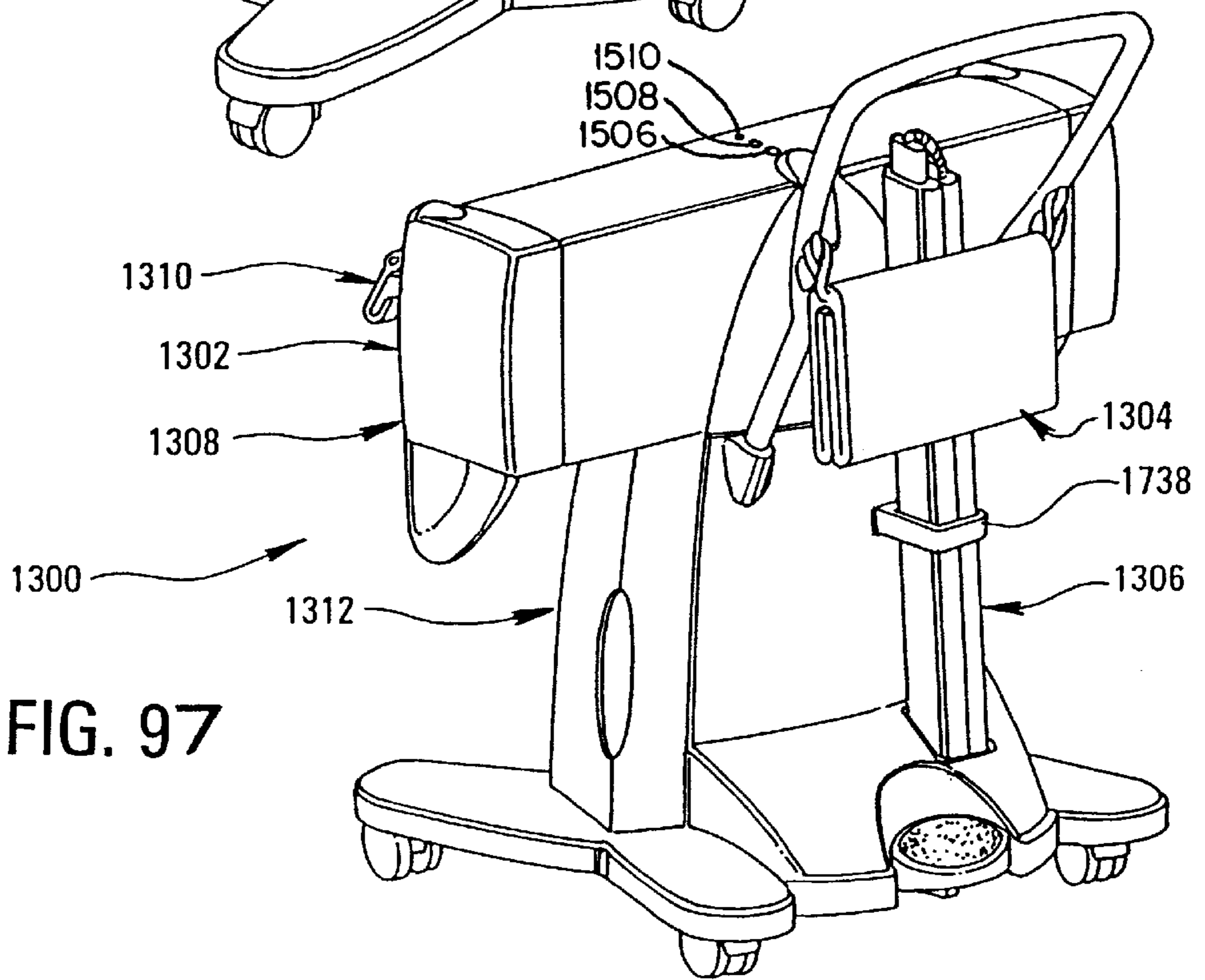


FIG. 97



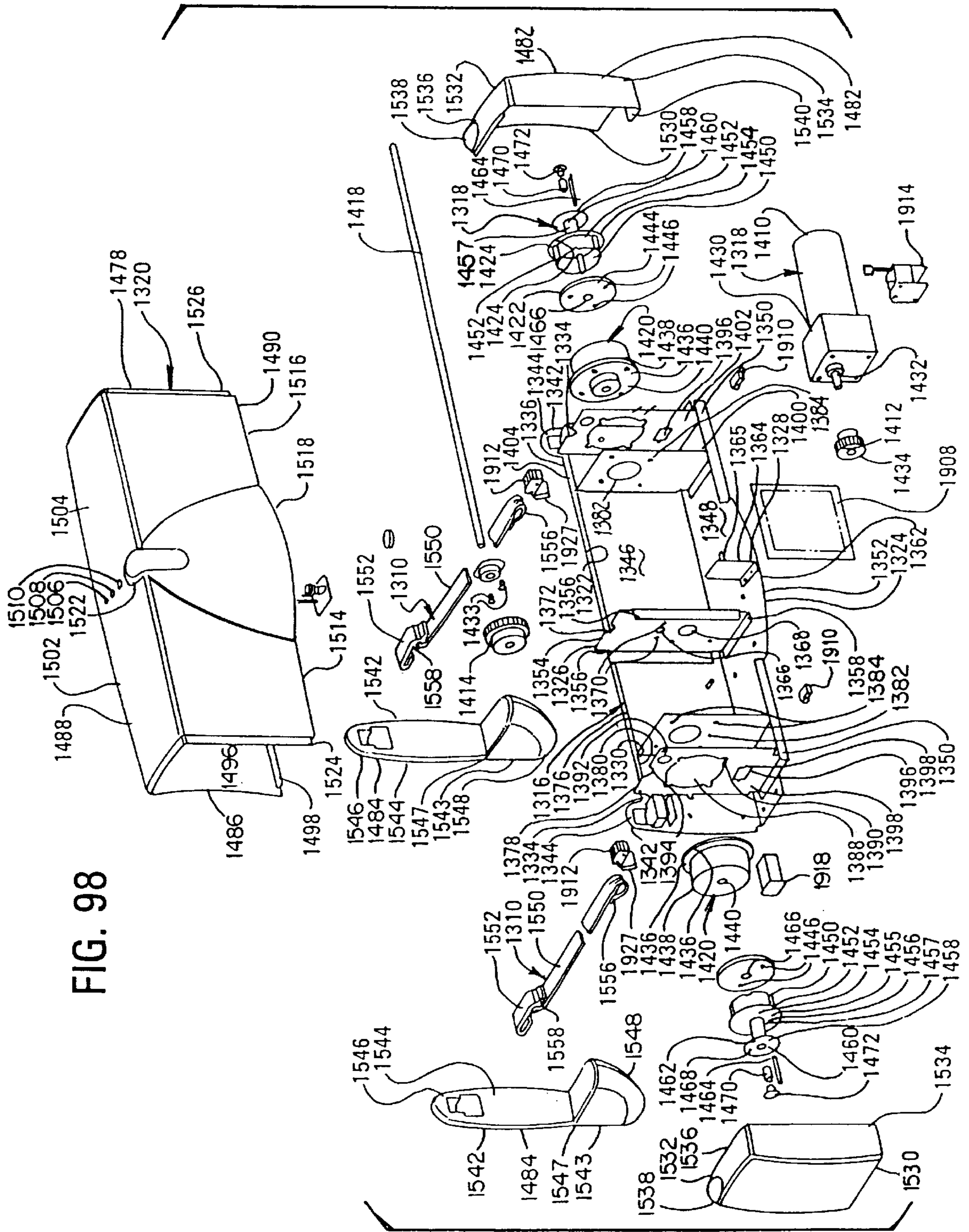


FIG. 98

FIG. 99

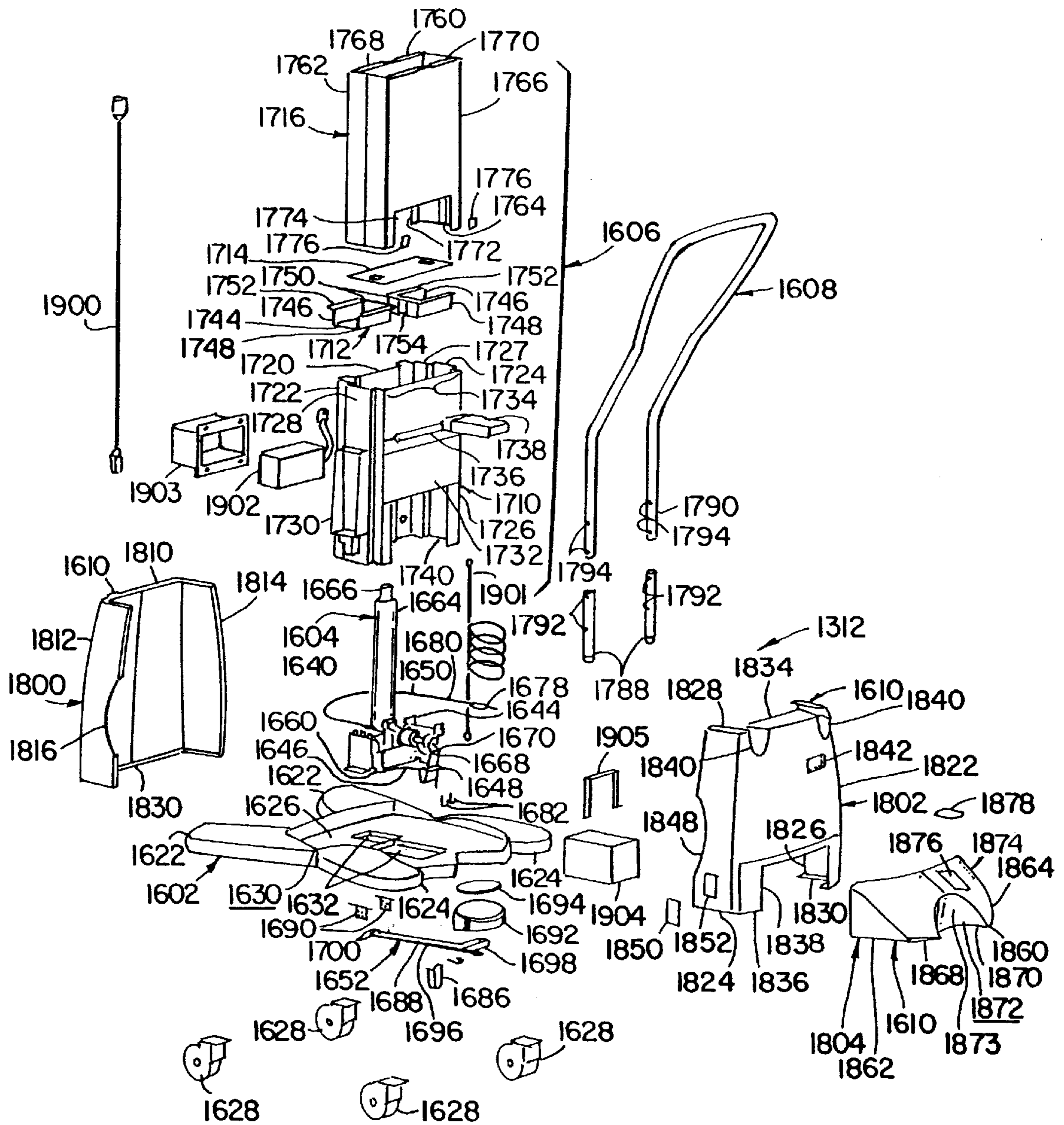




FIG. 100

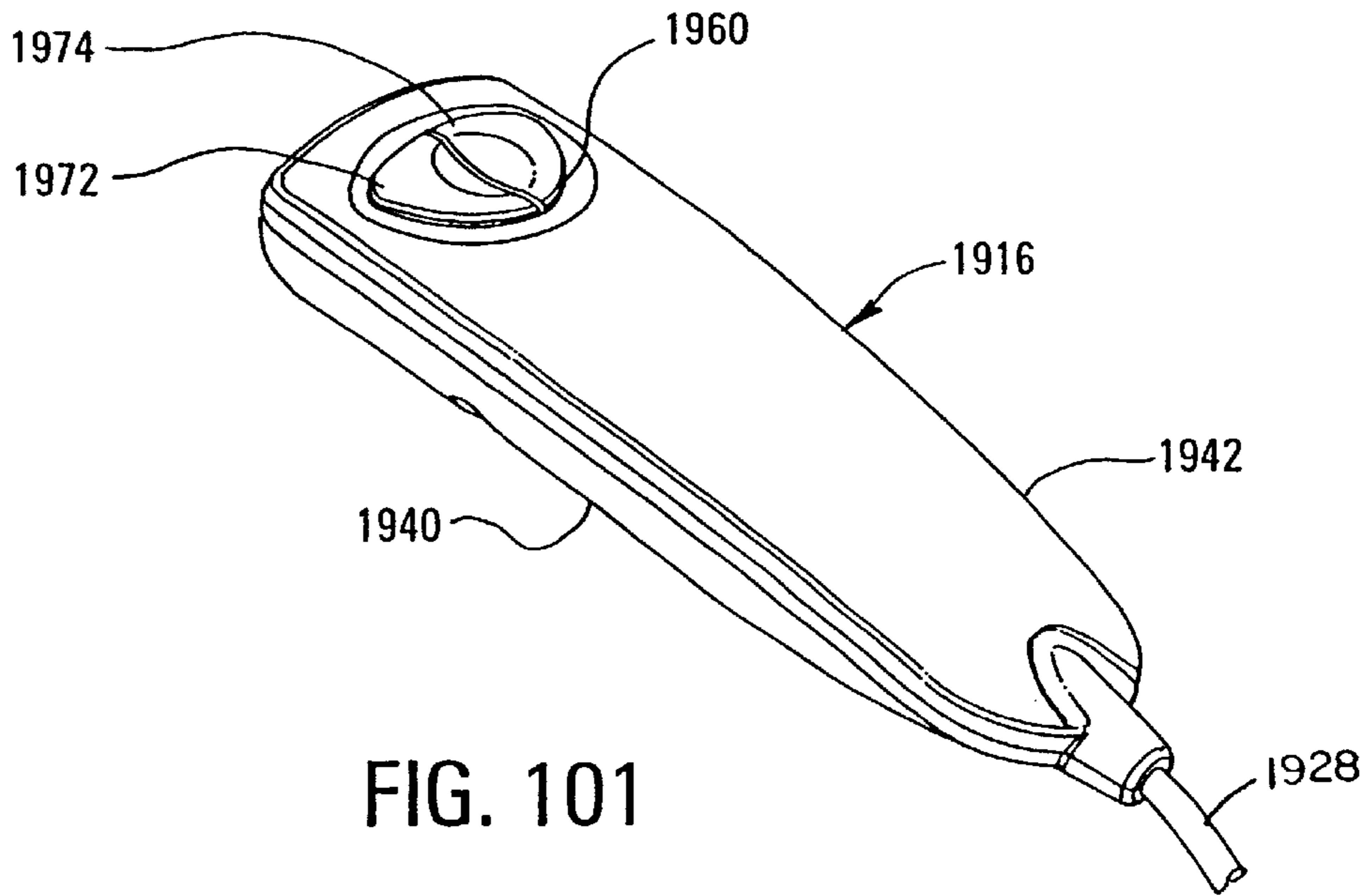
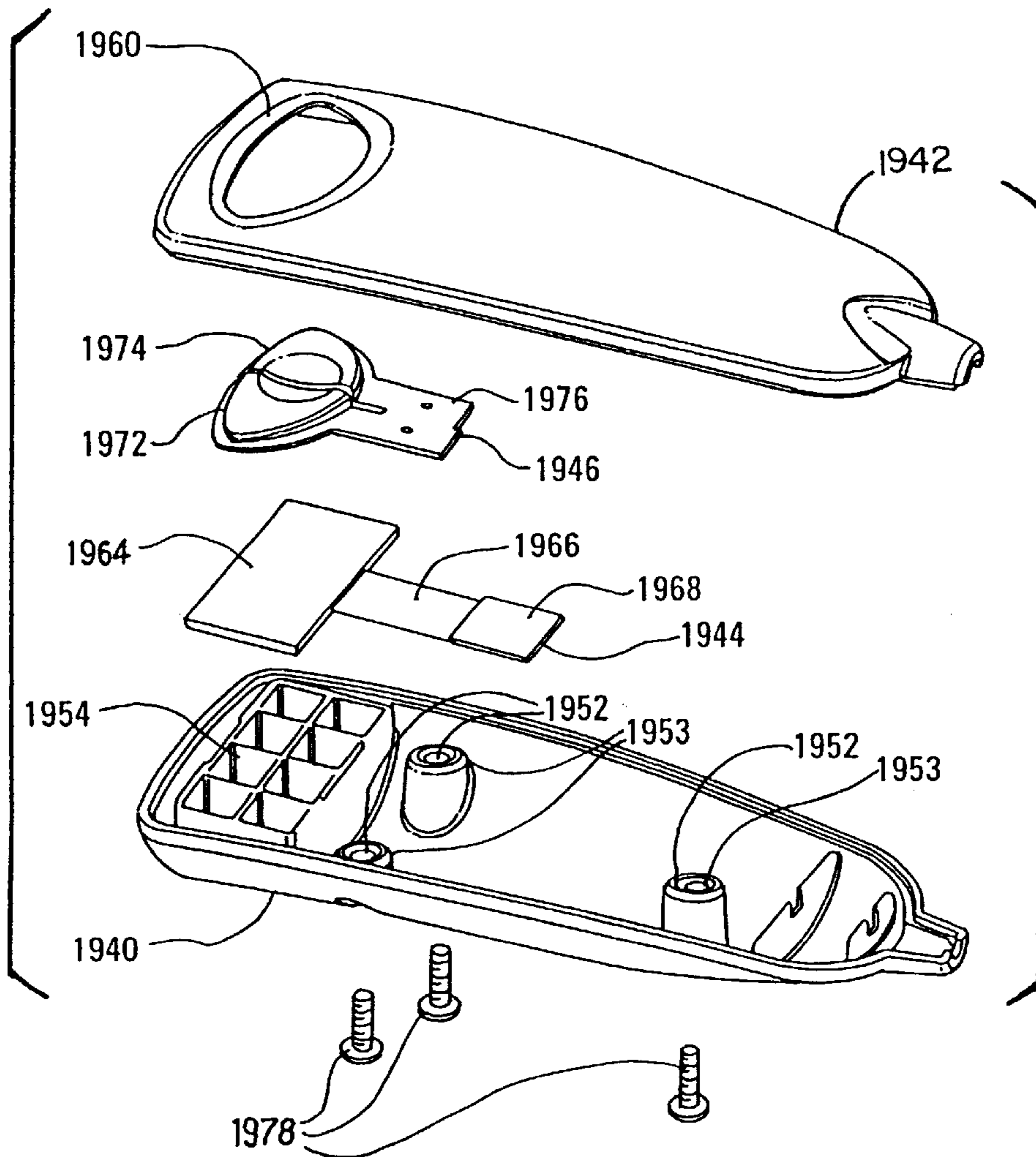
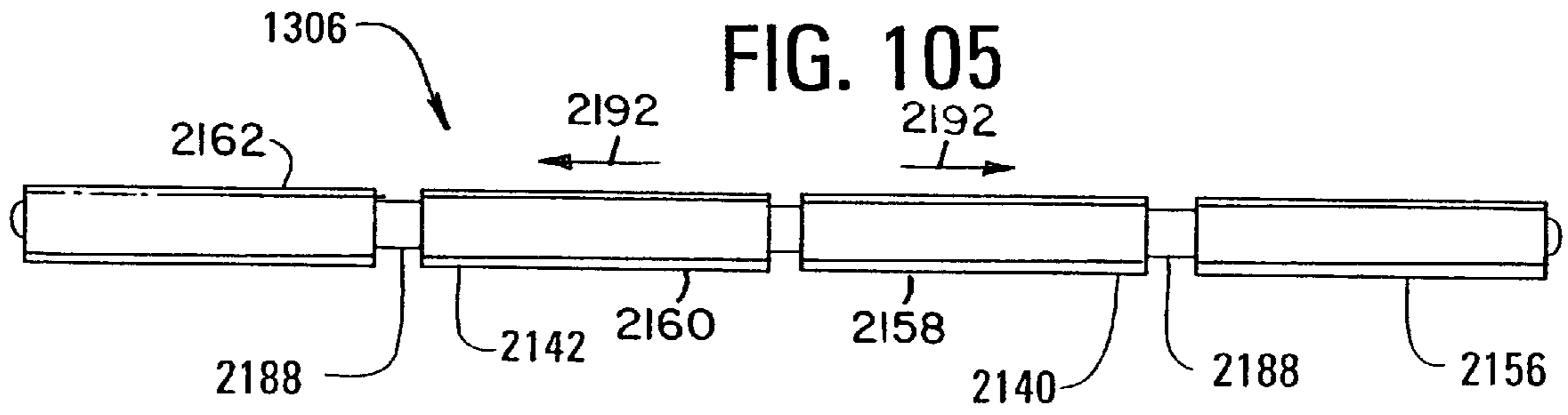


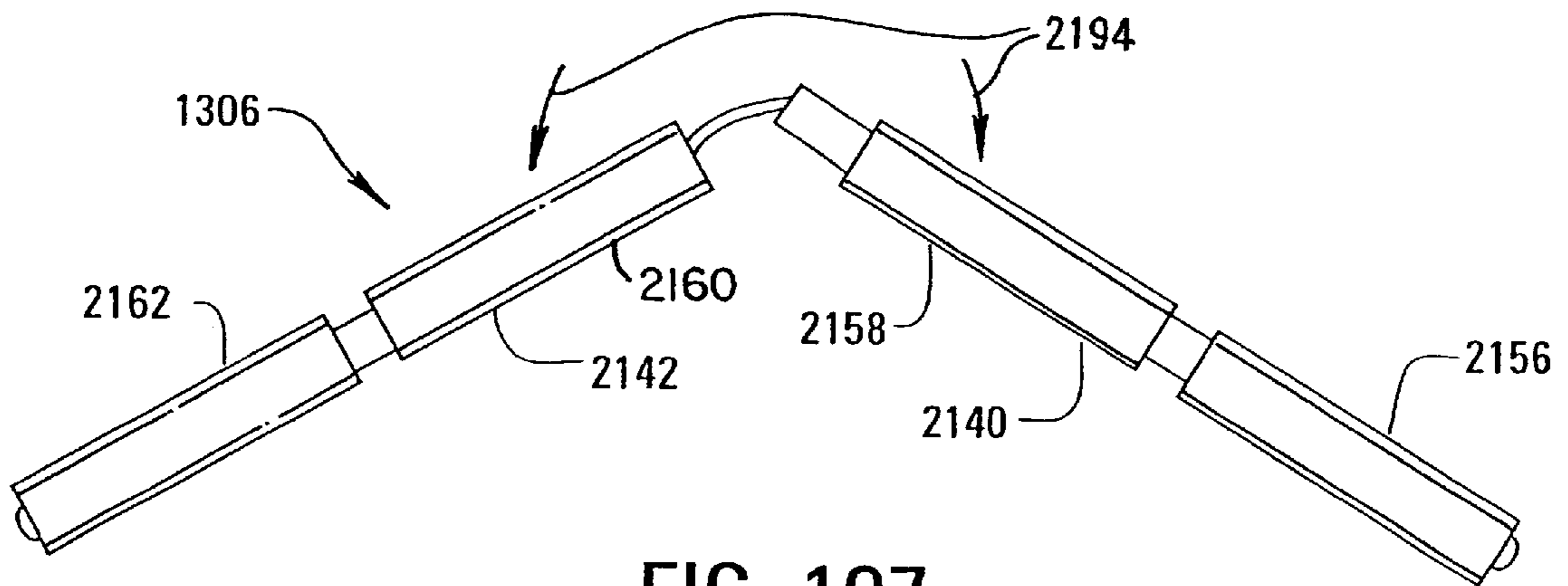
FIG. 101







**FIG. 106**



**FIG. 107**

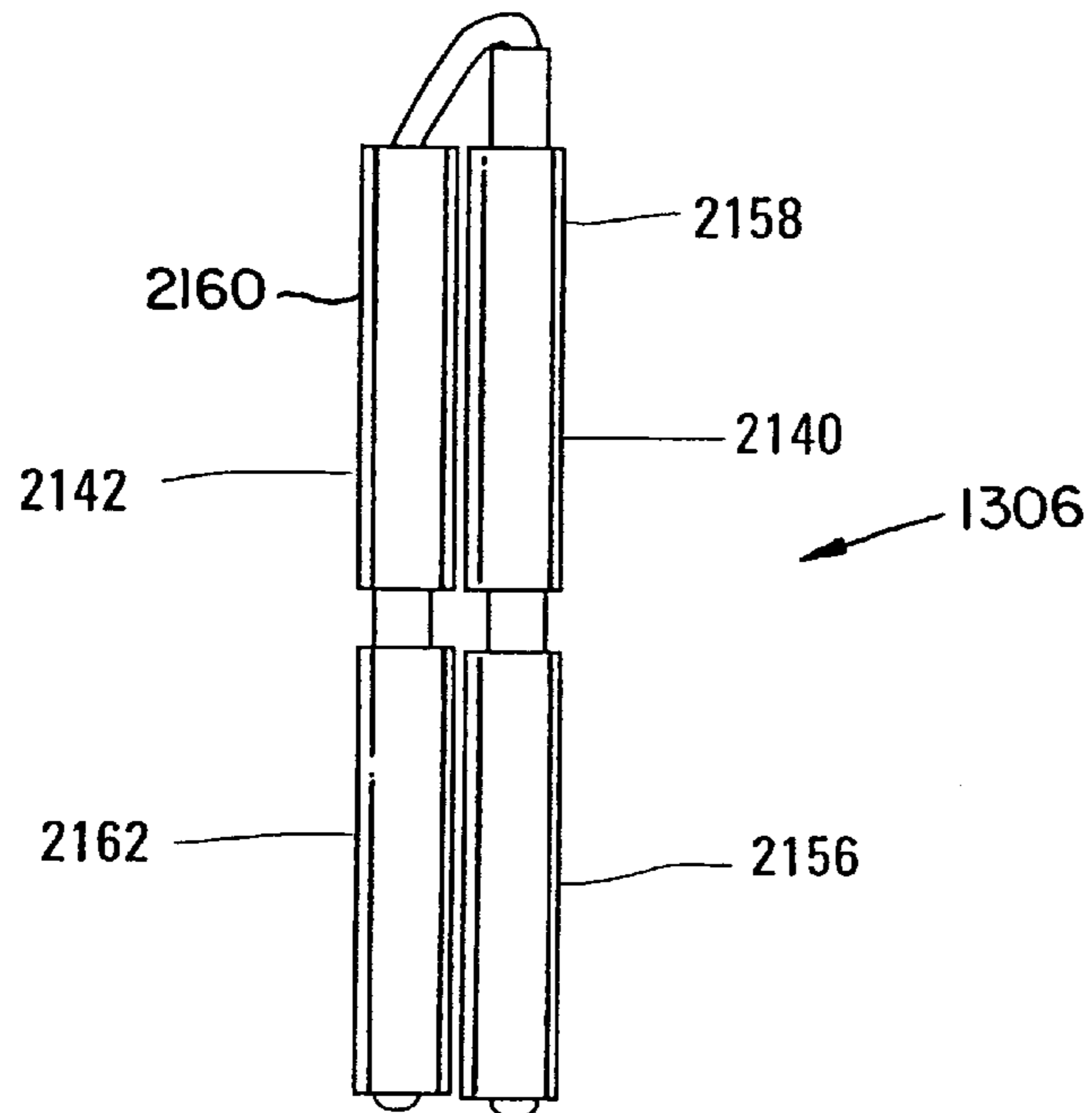




FIG. 108

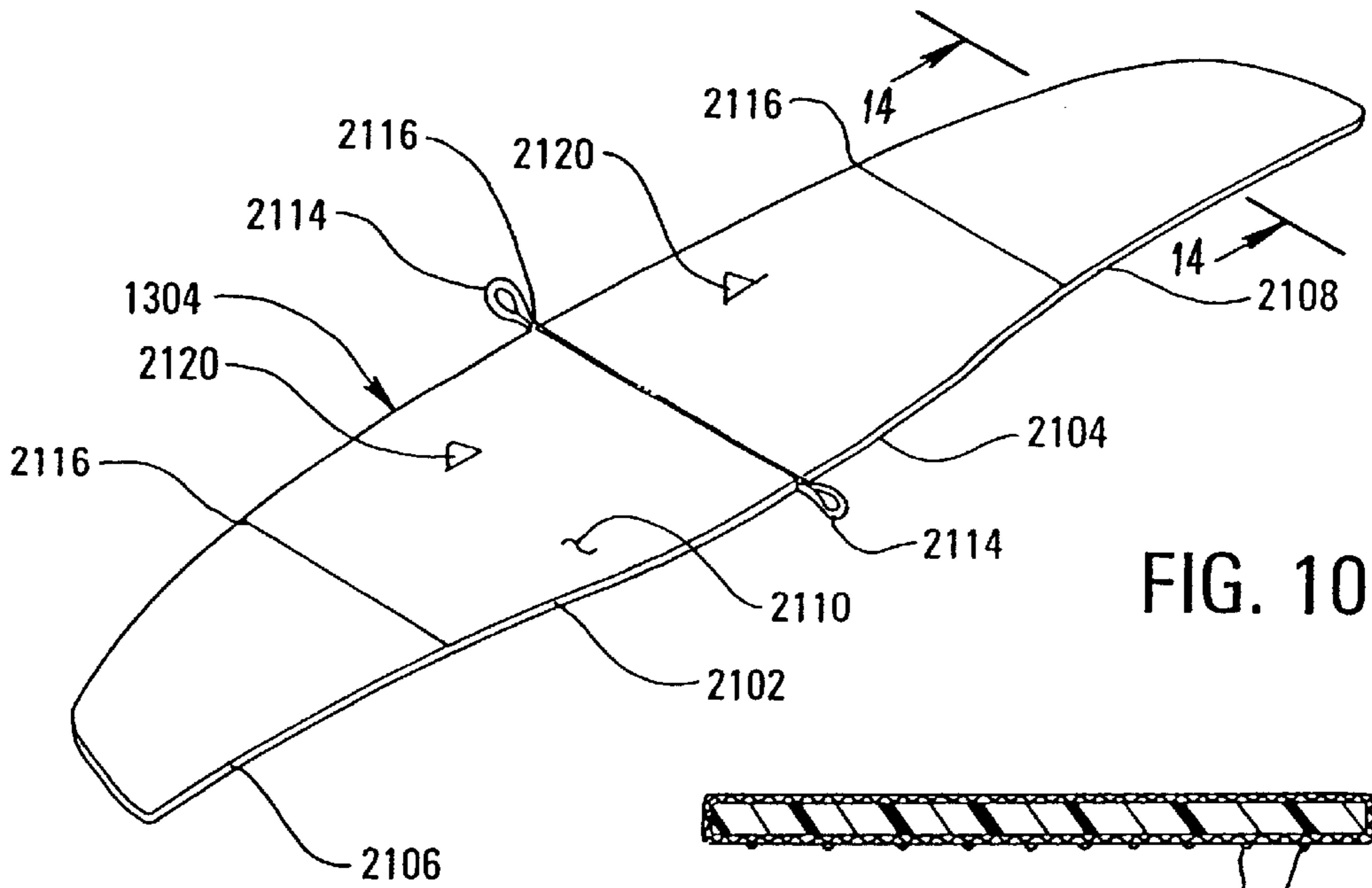


FIG. 109

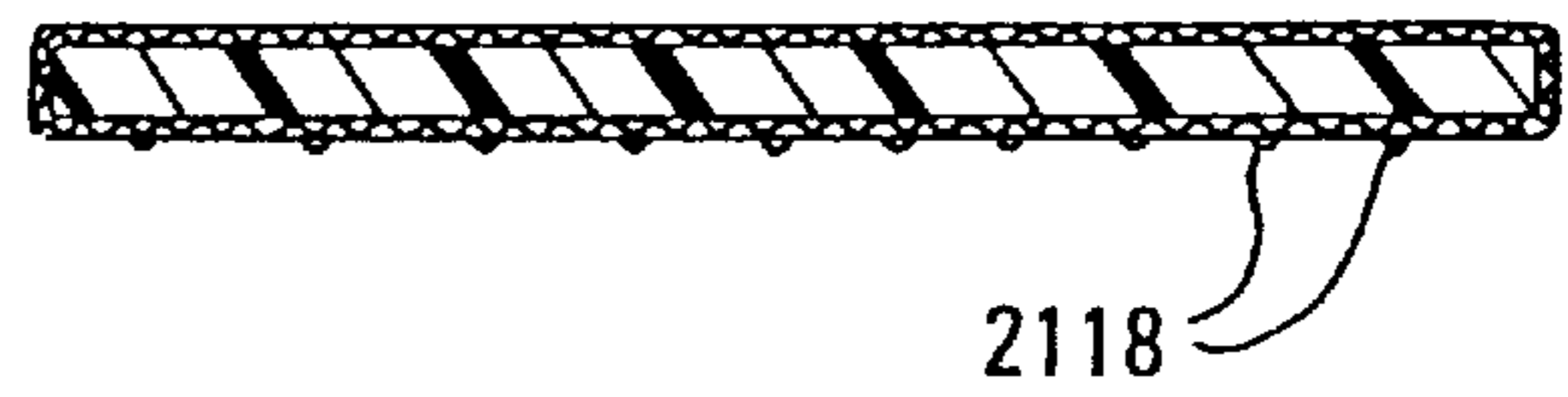


FIG. 110

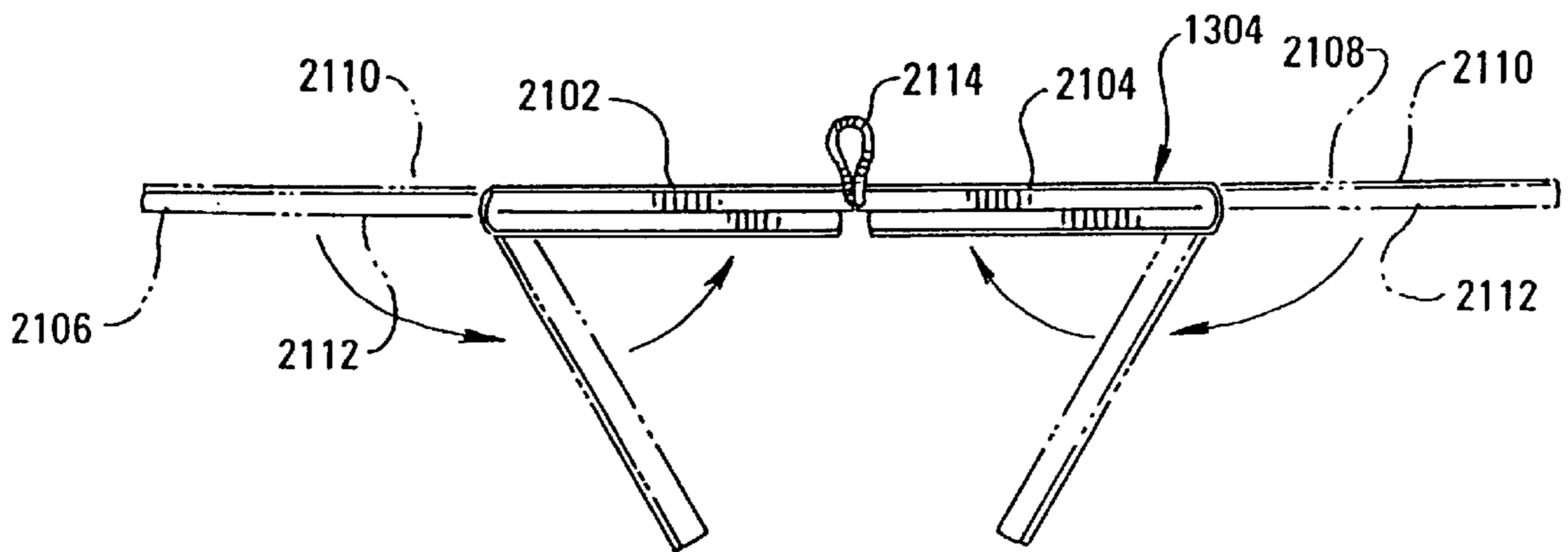


FIG. 111

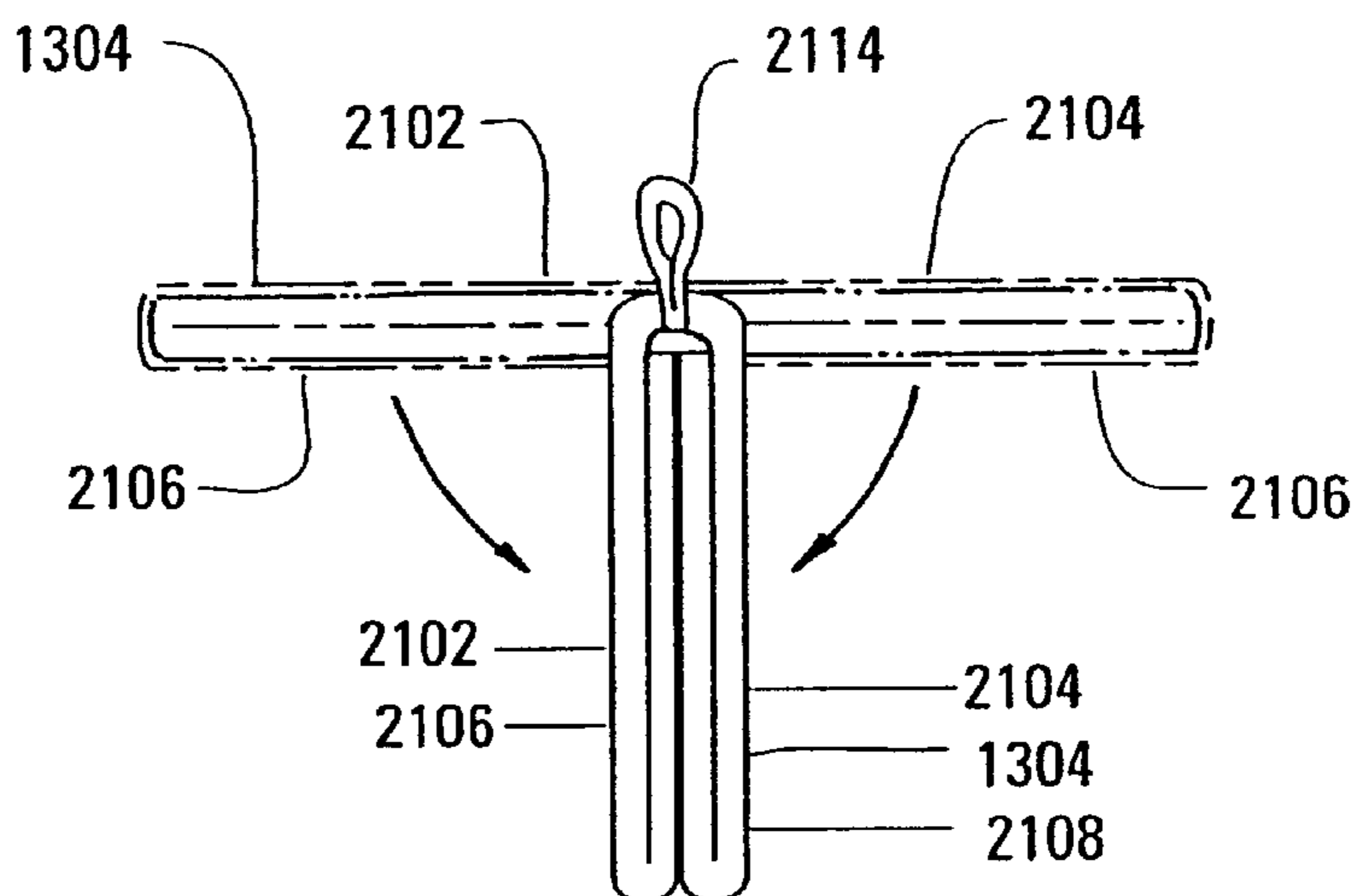


FIG. 112

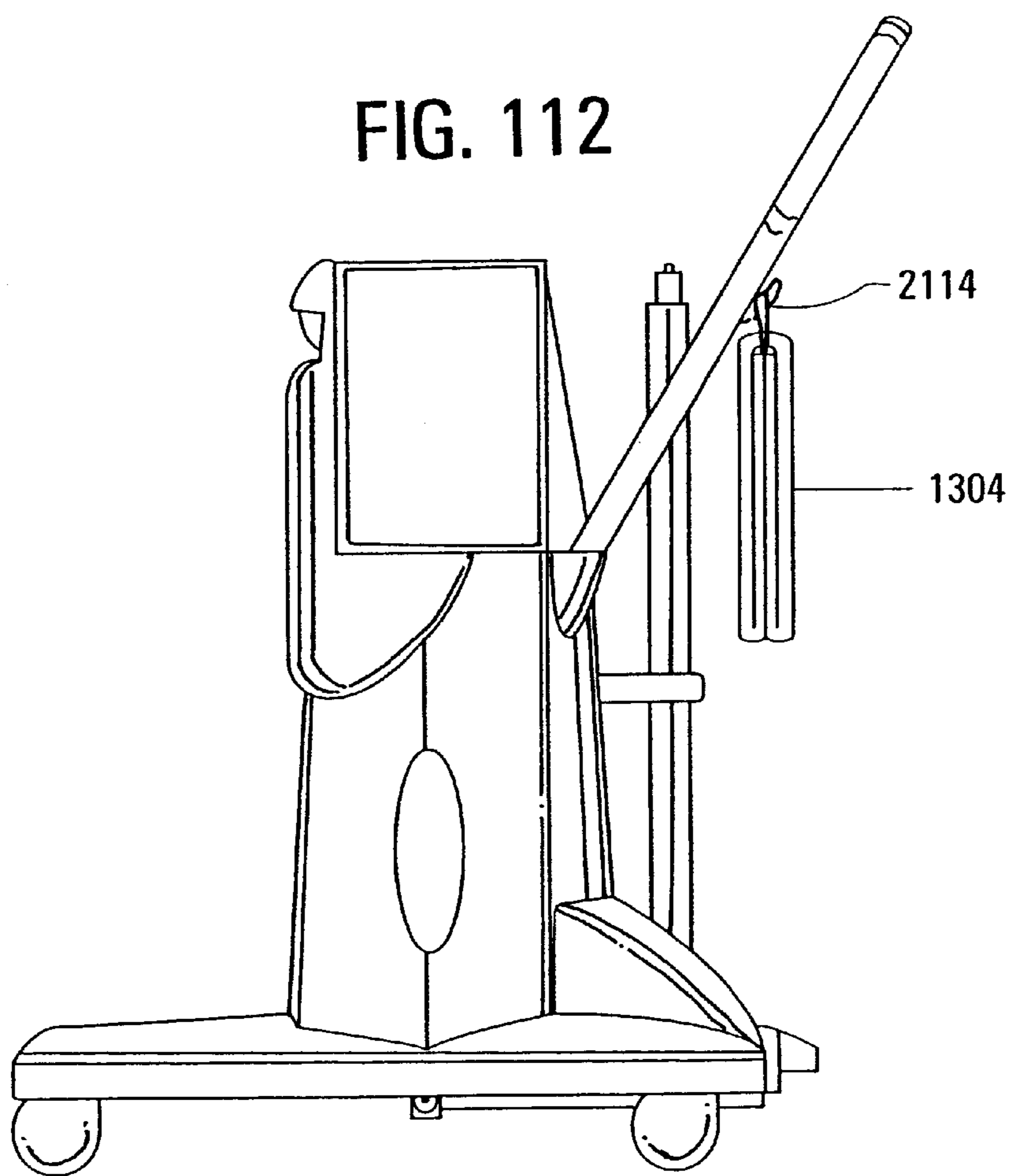


FIG. 113

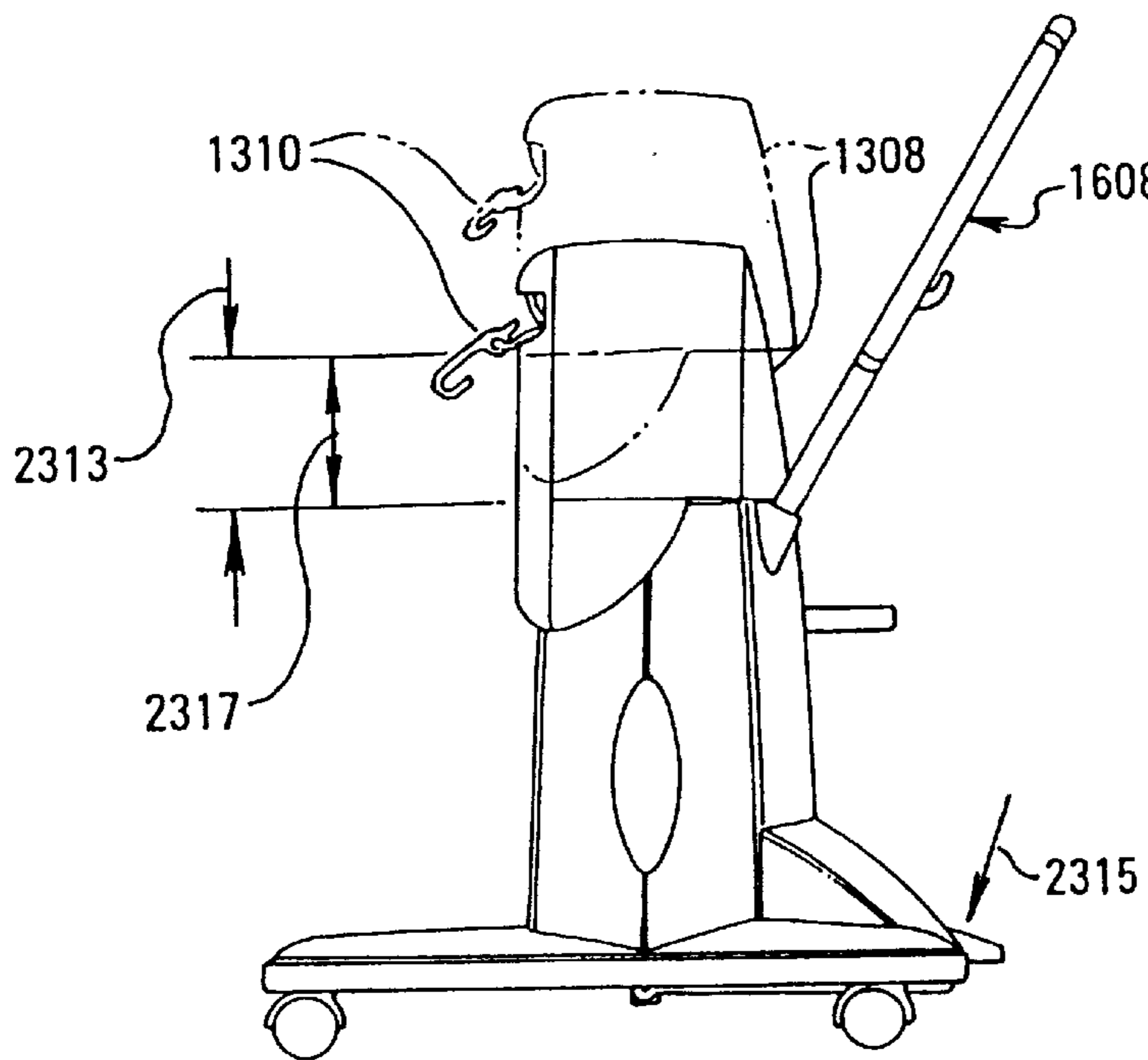


FIG. 114

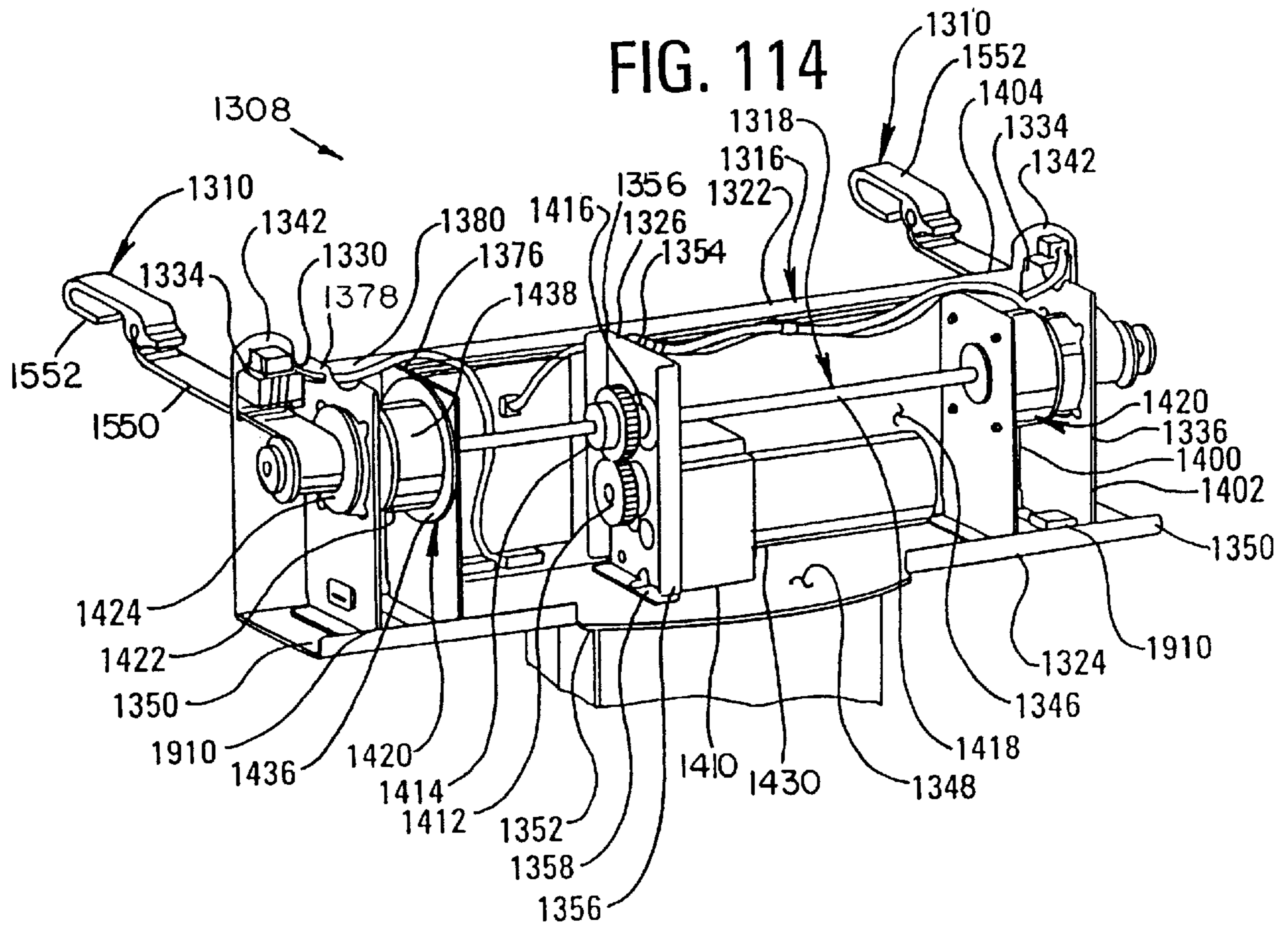




FIG. 115

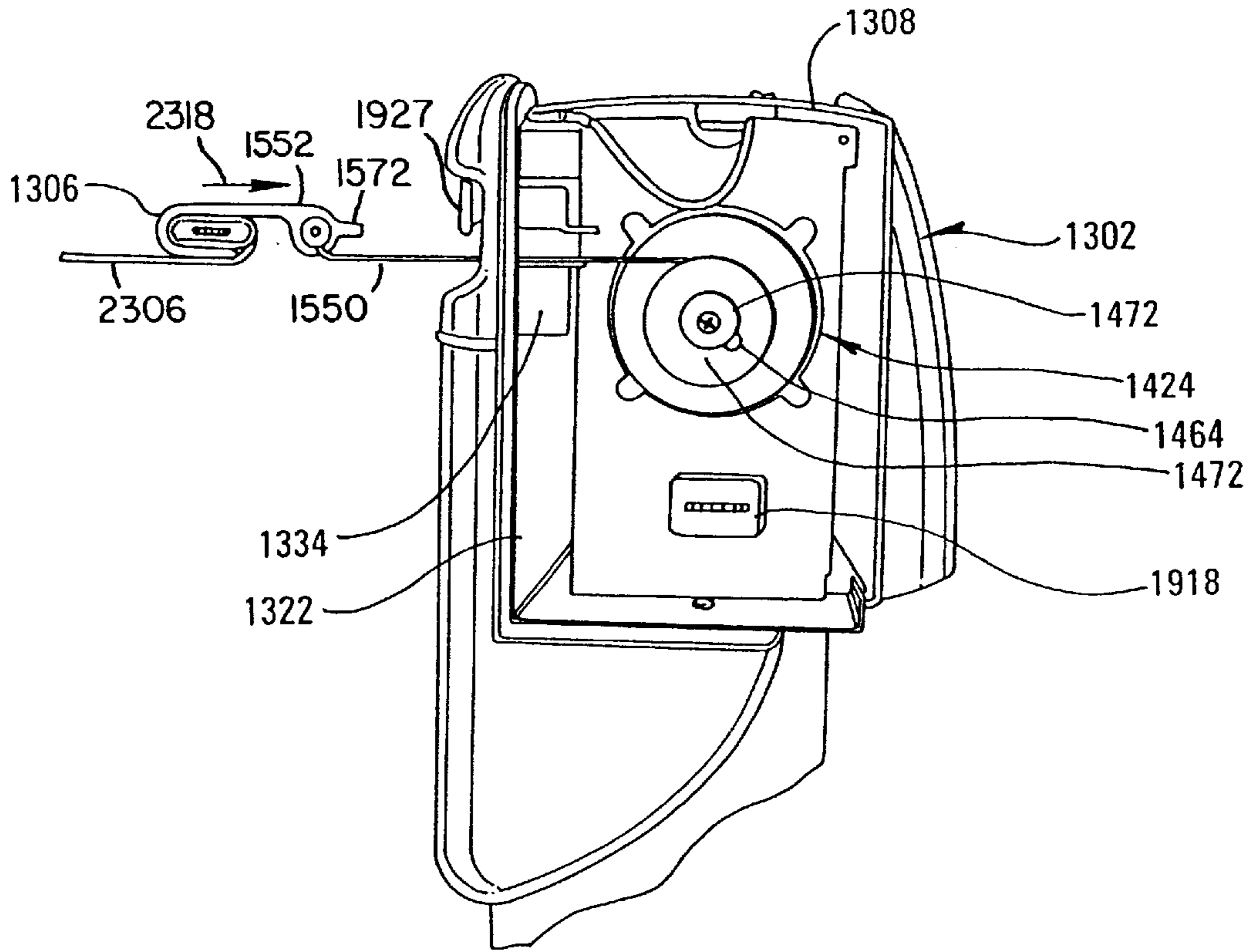


FIG. 116

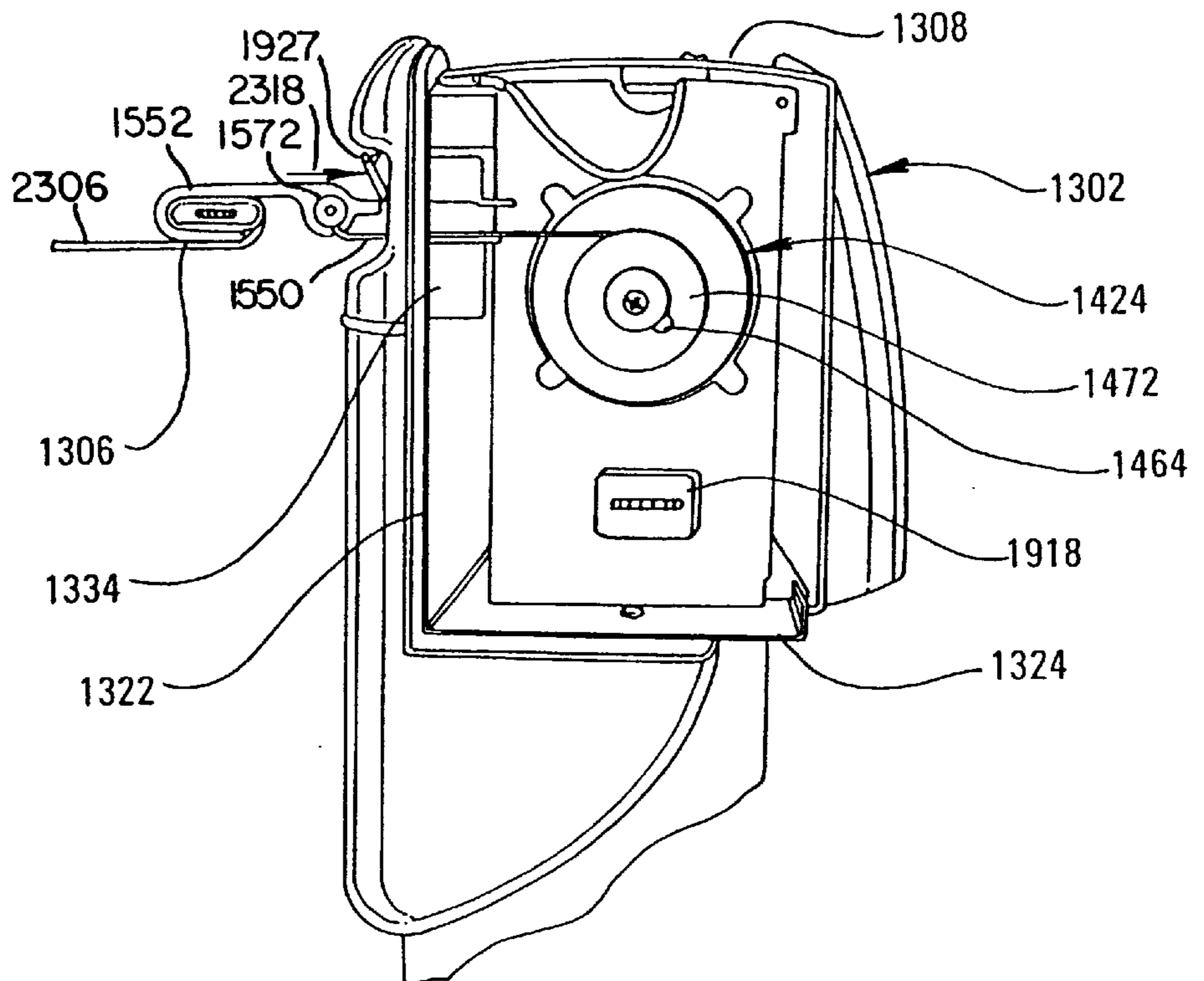


FIG. 117

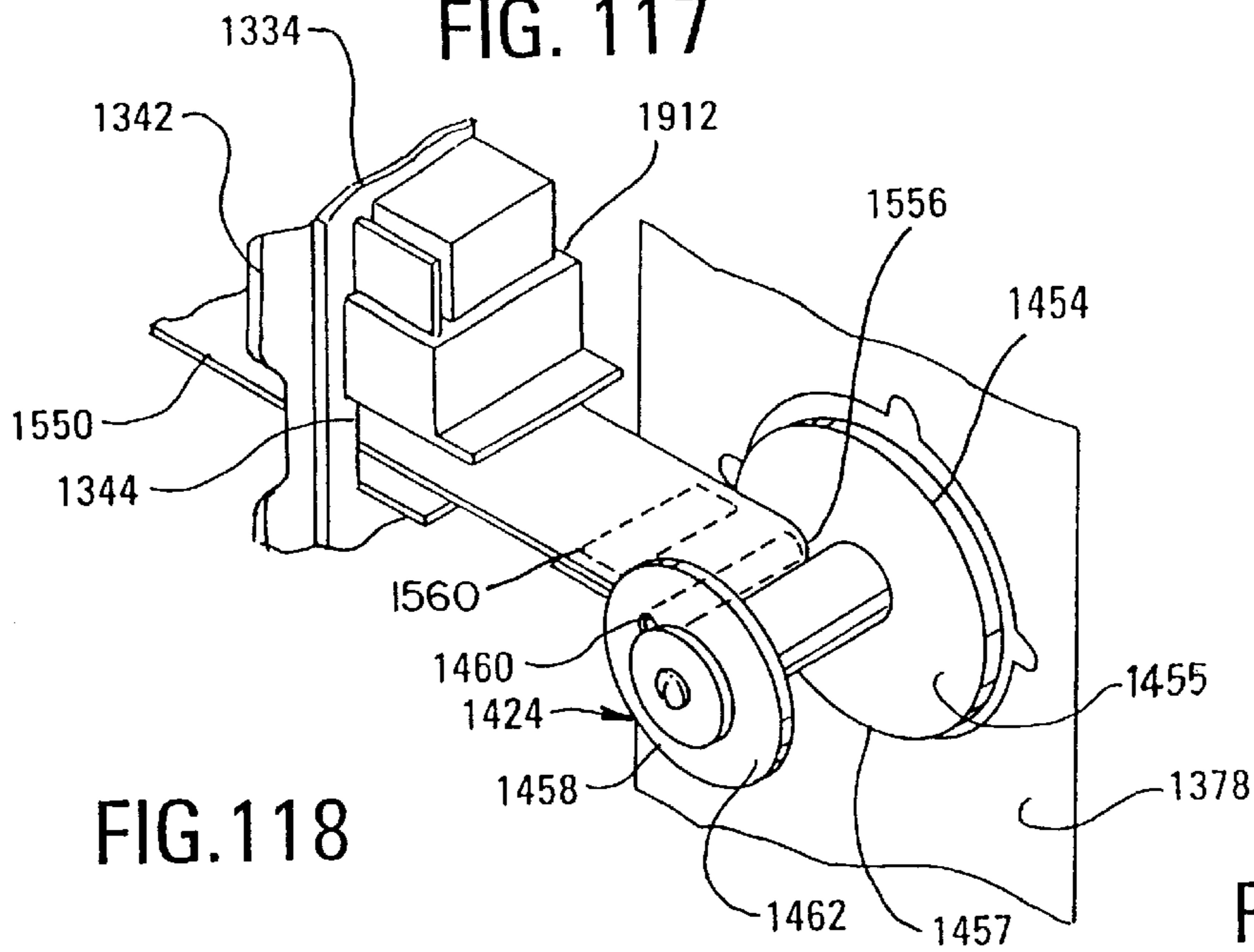


FIG. 118

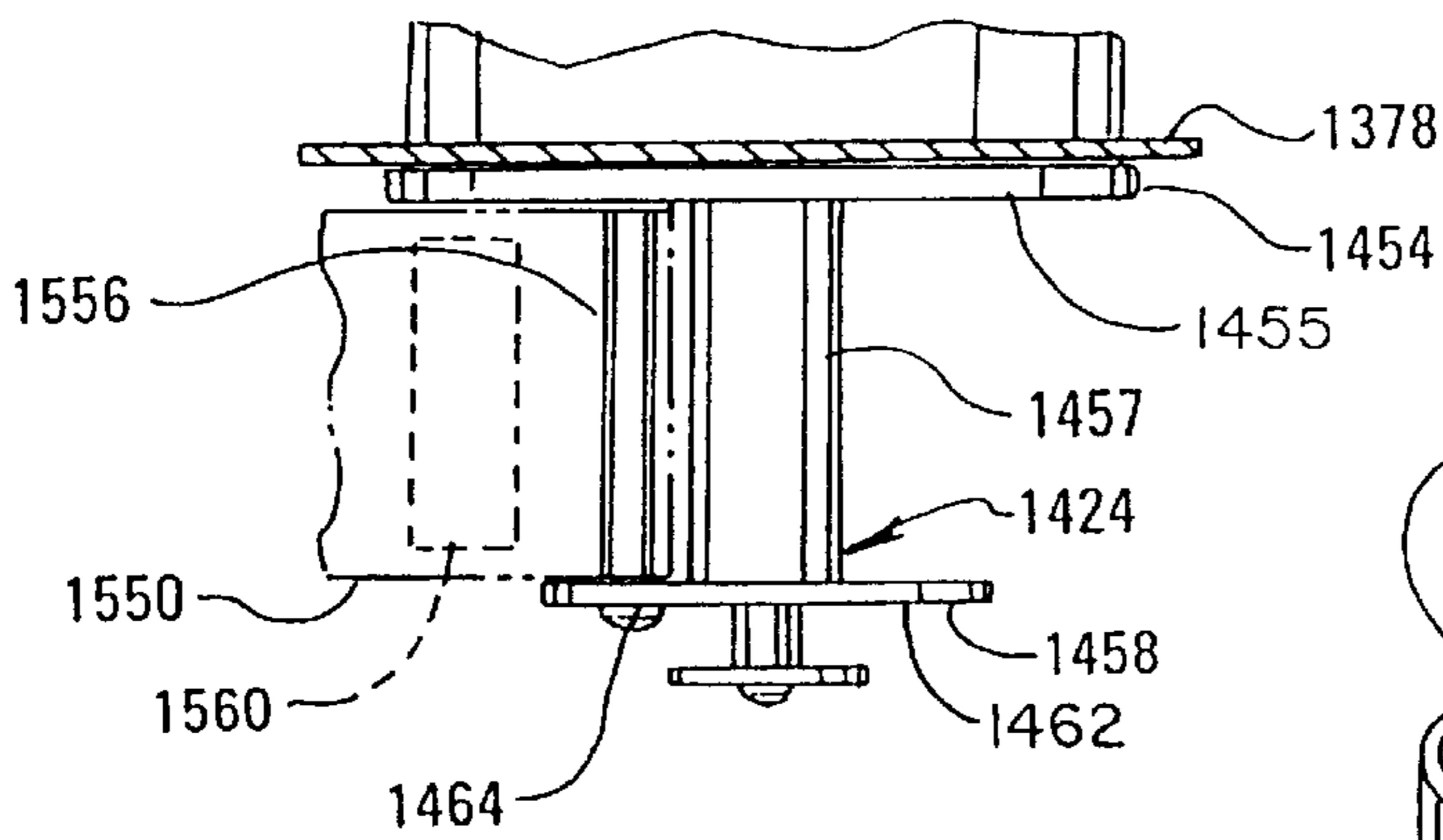


FIG. 119

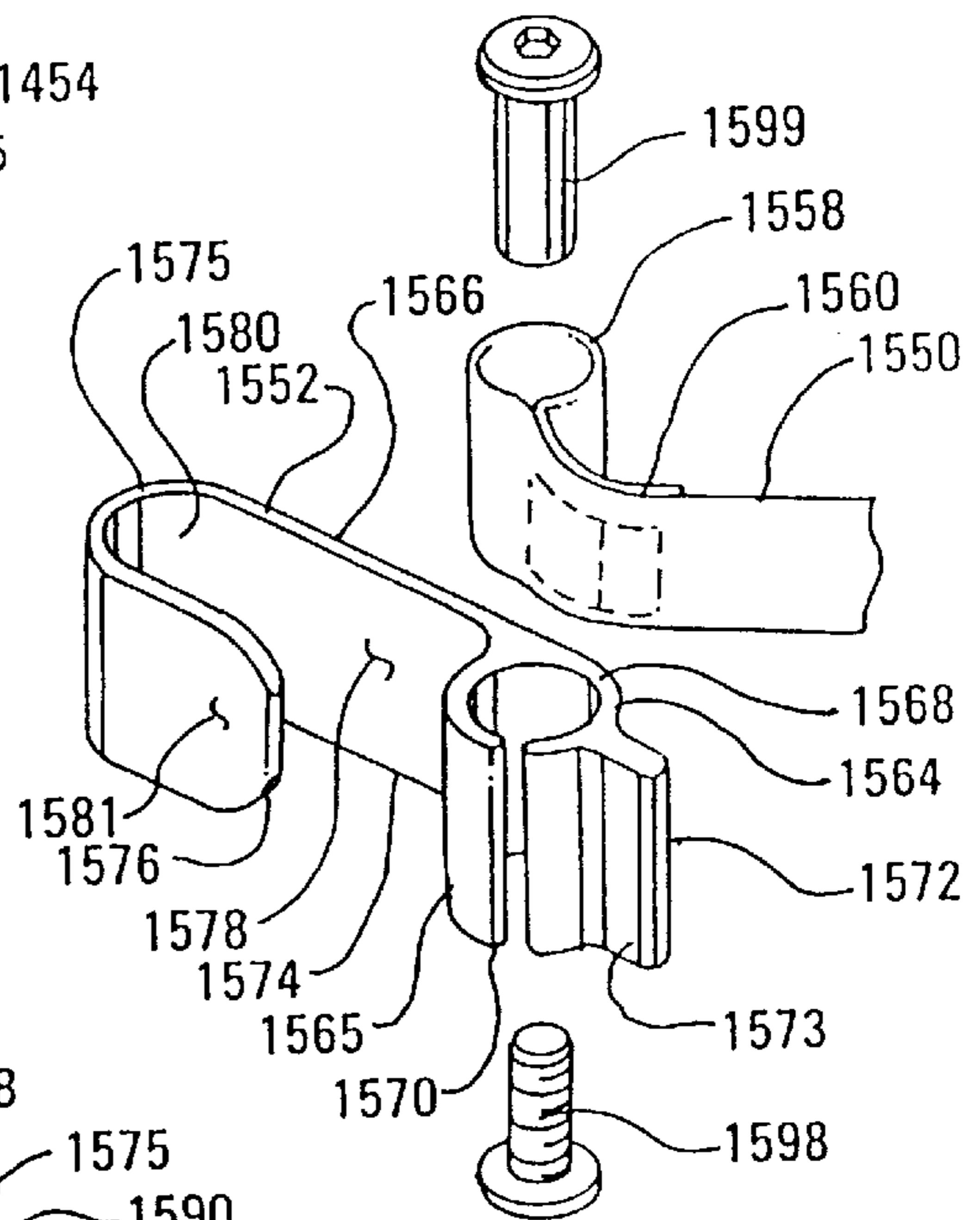


FIG. 120

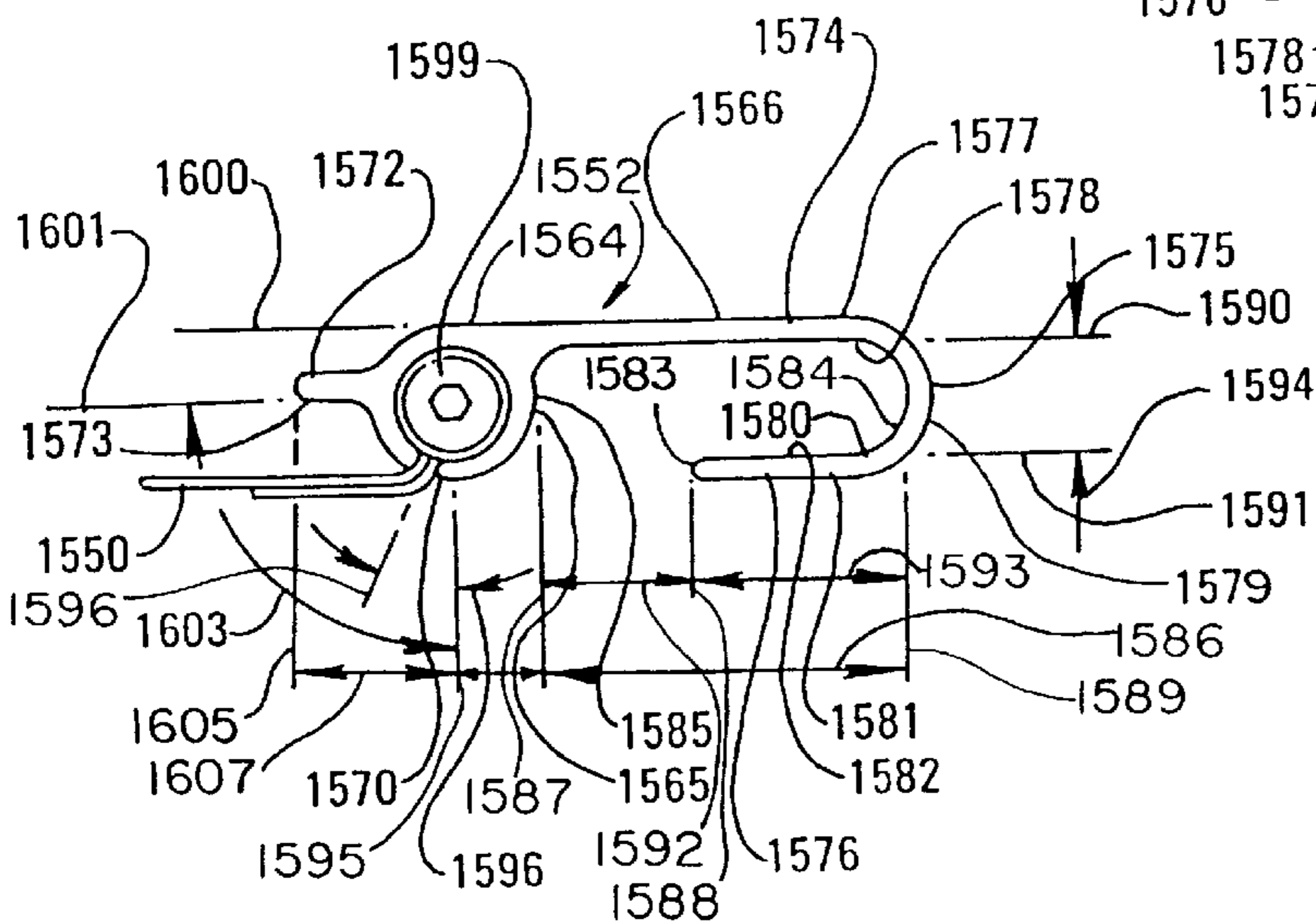


FIG. 121

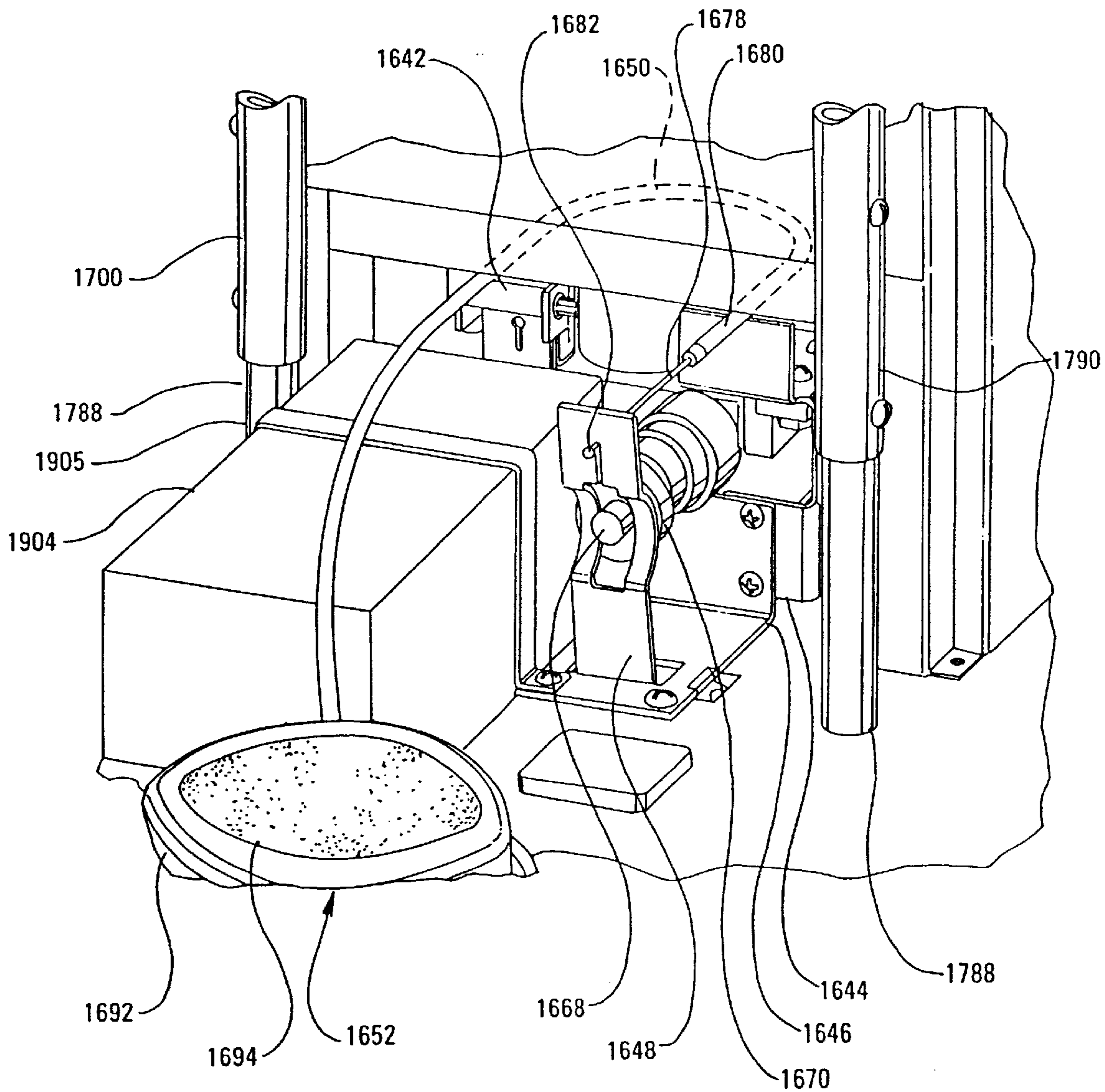




FIG. 122

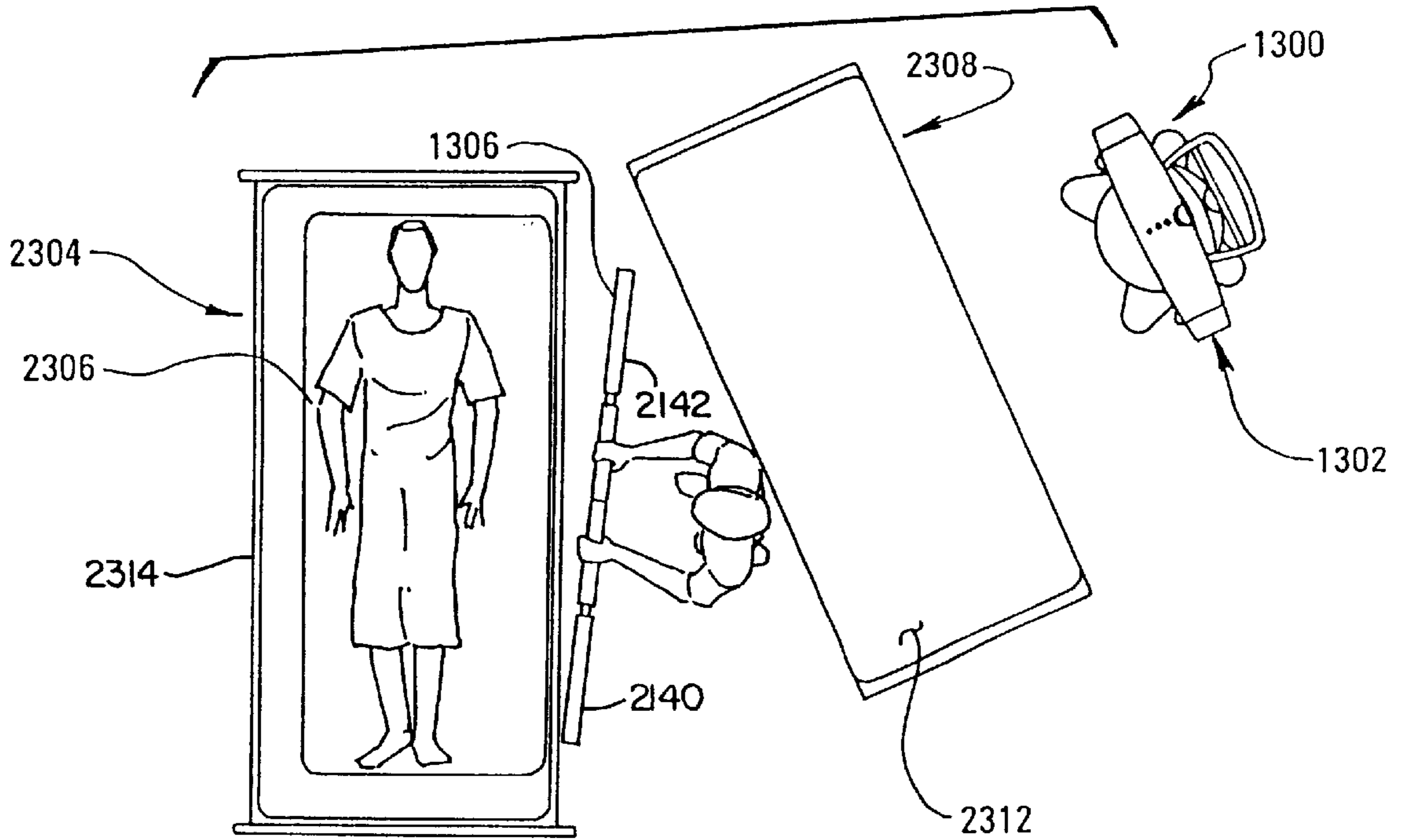


FIG. 123

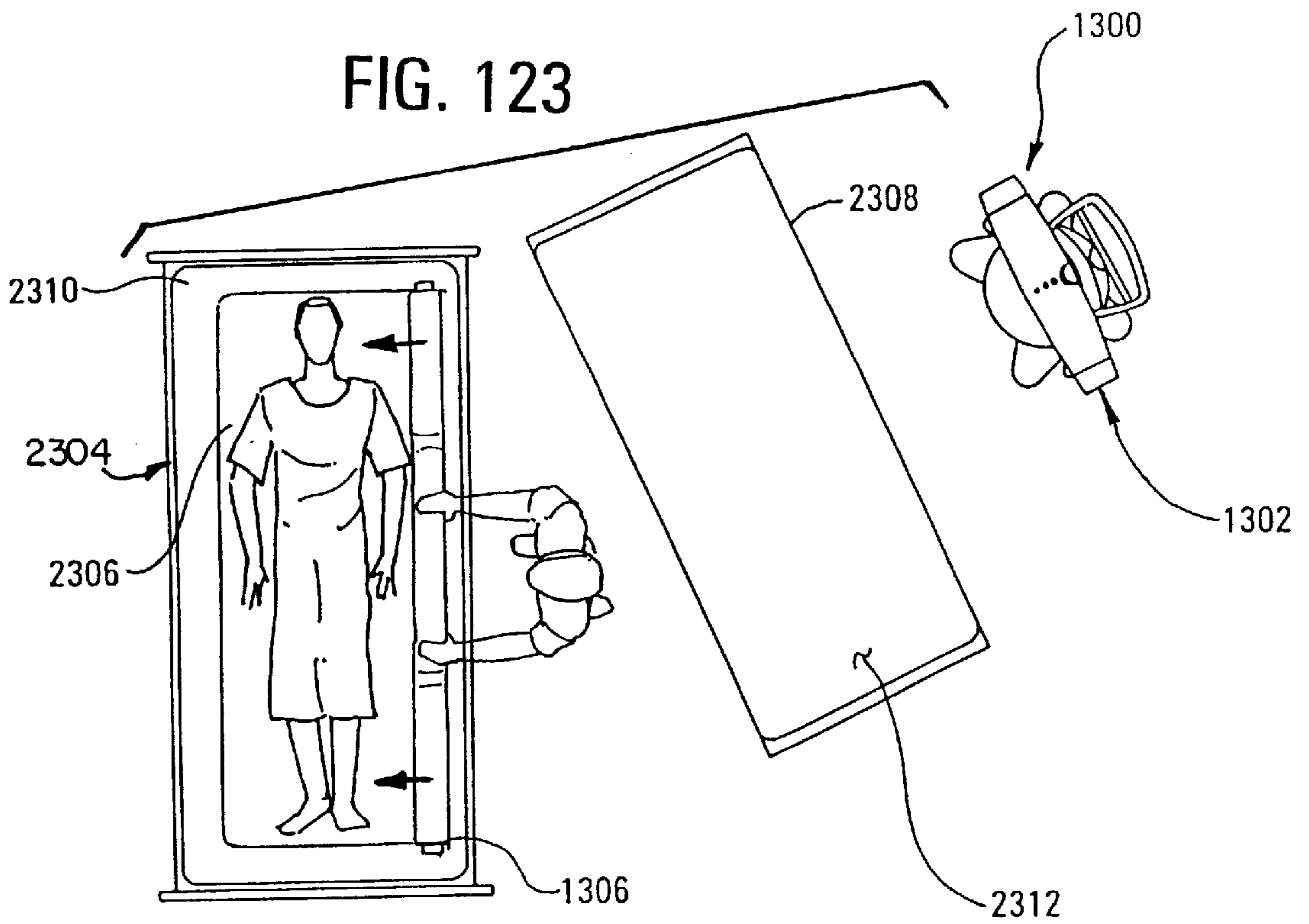


FIG. 124

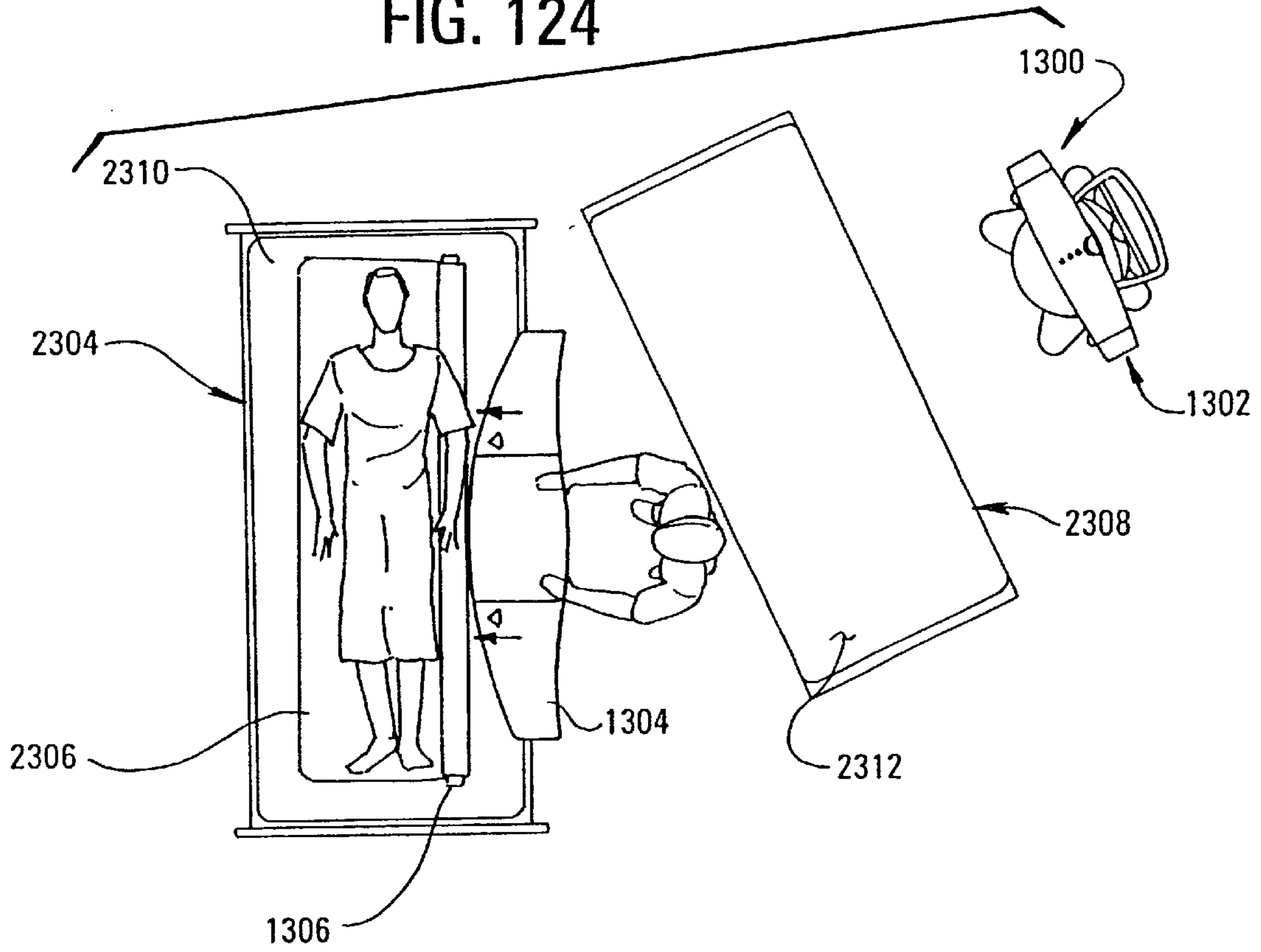


FIG. 125

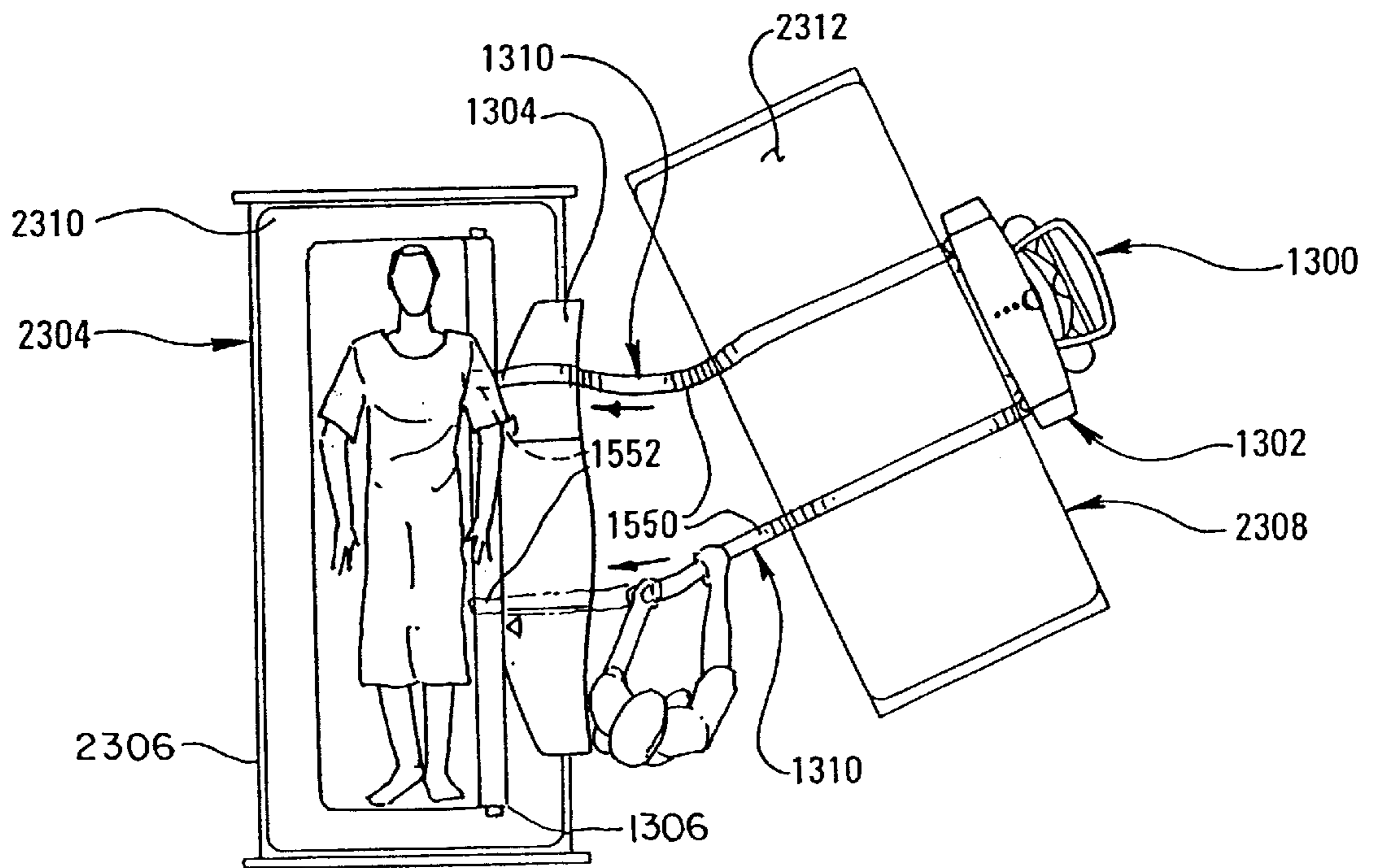


FIG. 126

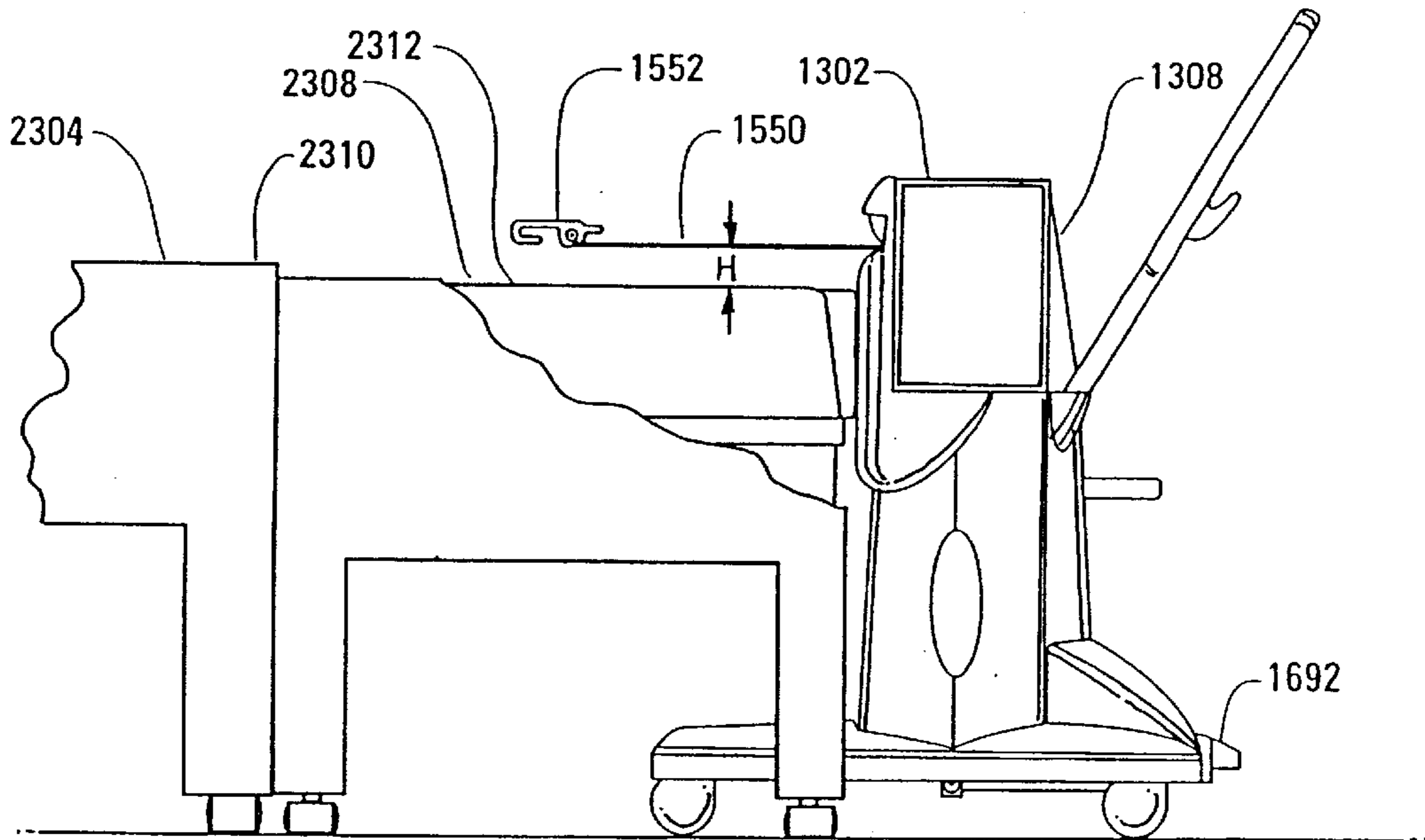


FIG. 128

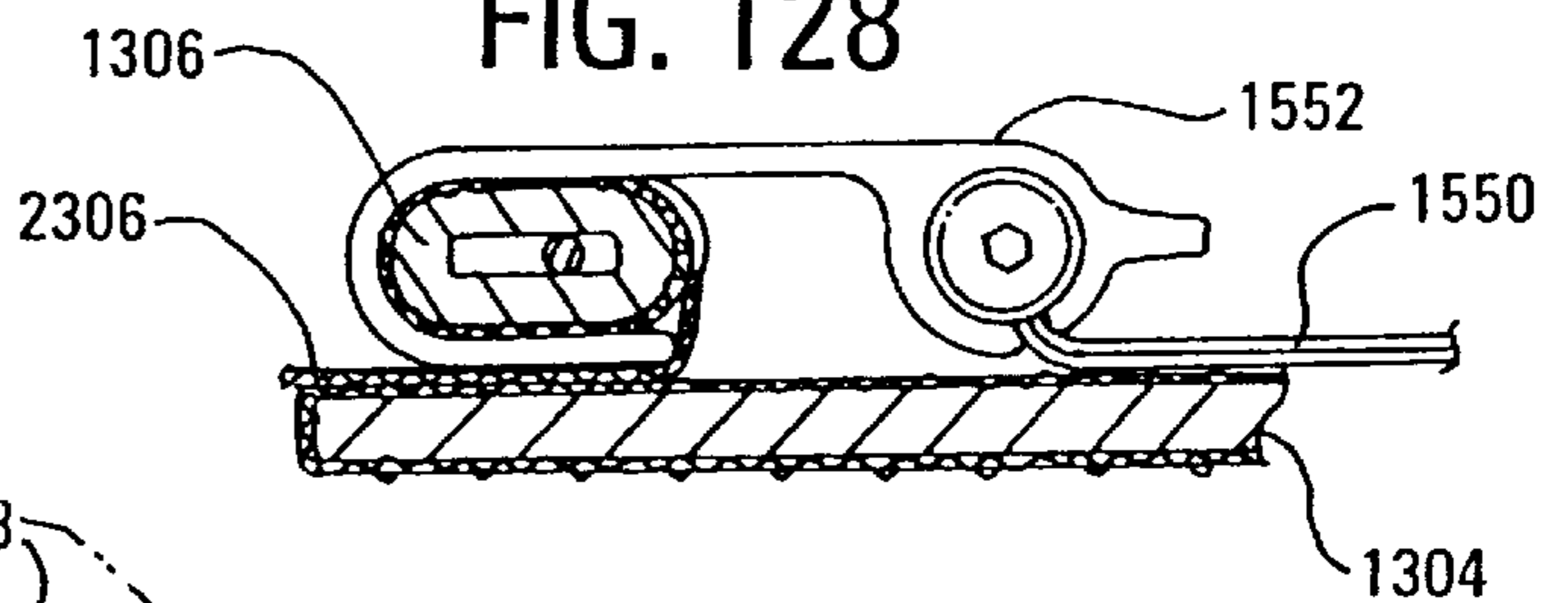


FIG. 127

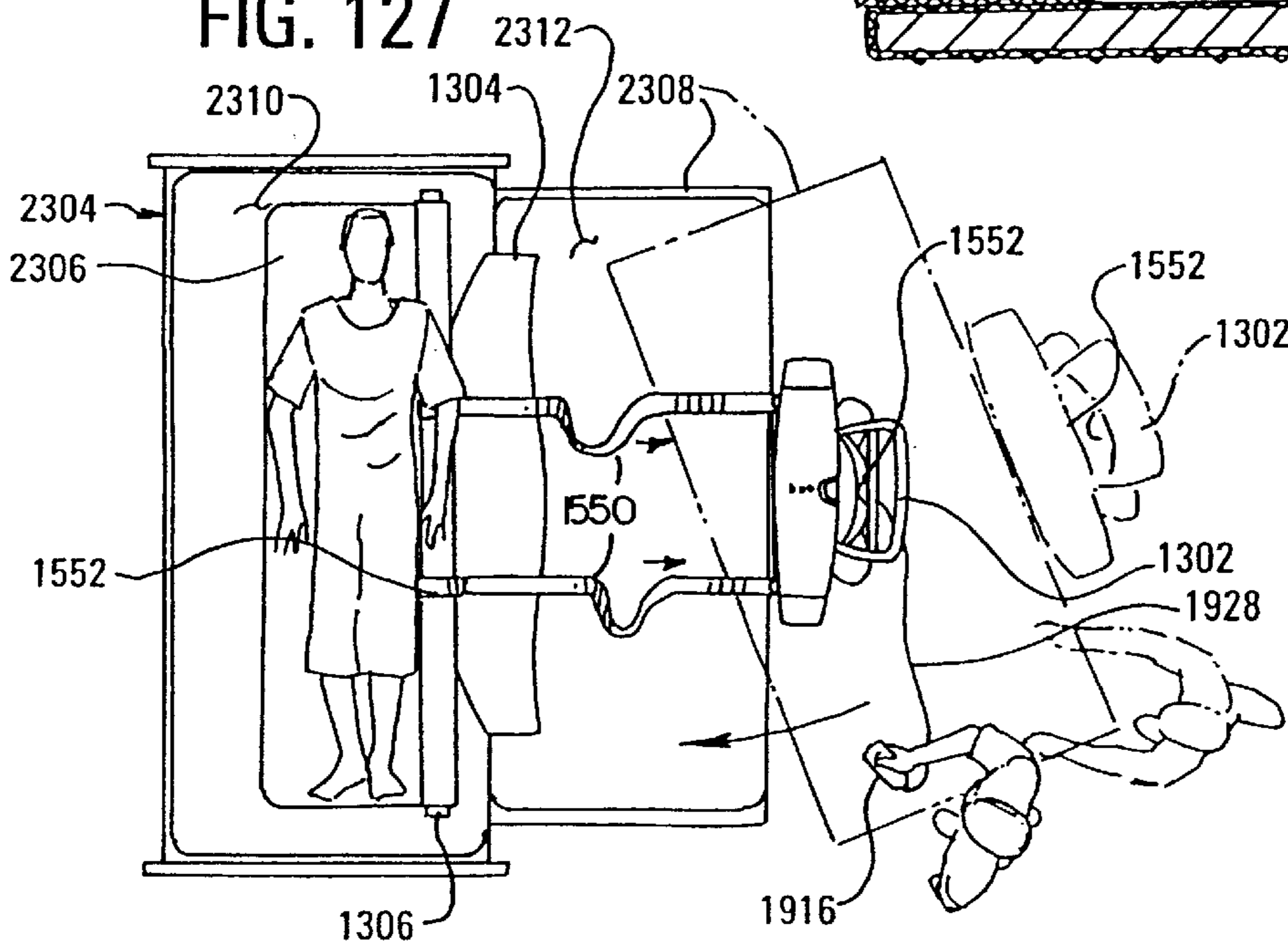




FIG. 129

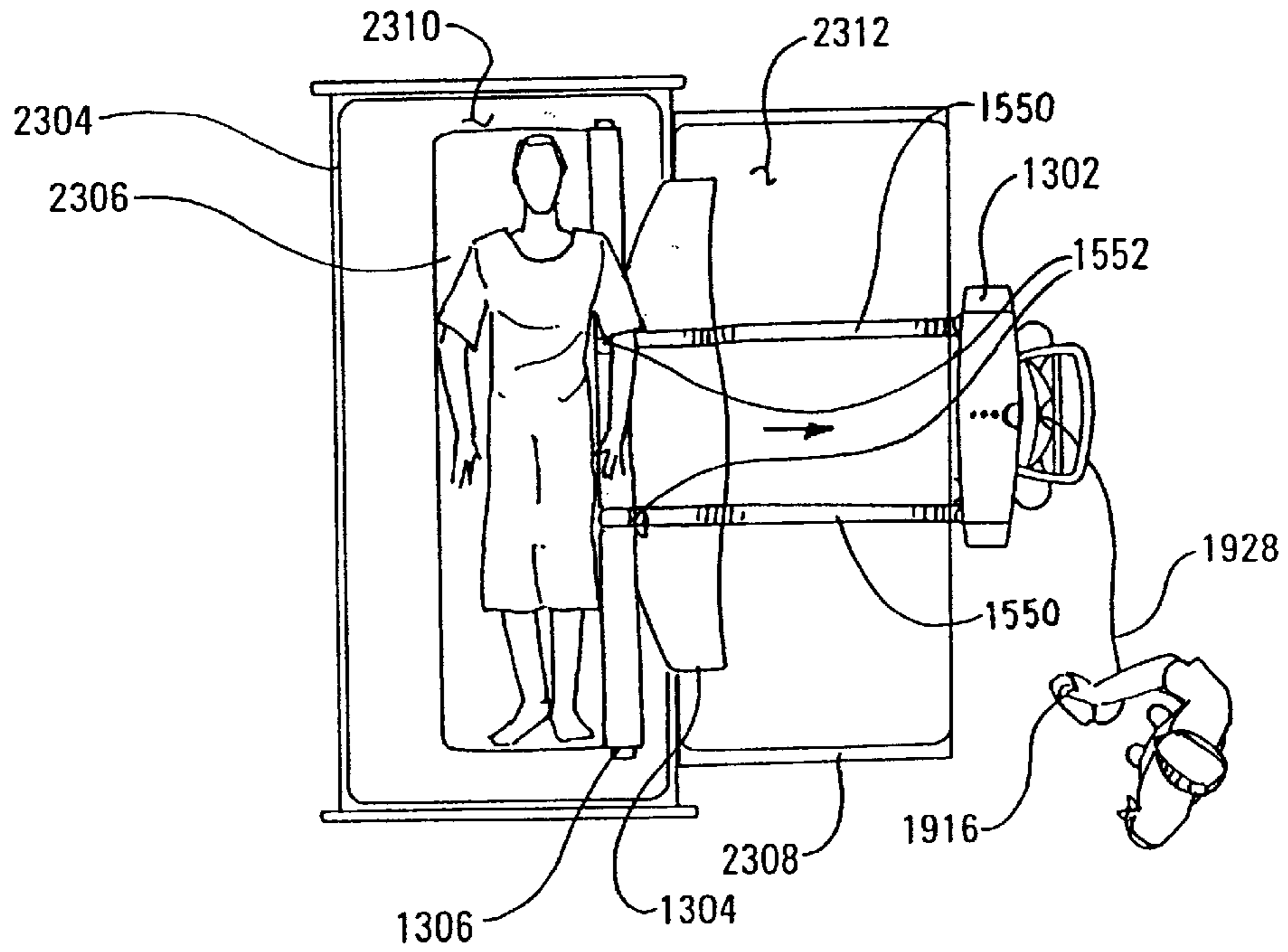


FIG. 130

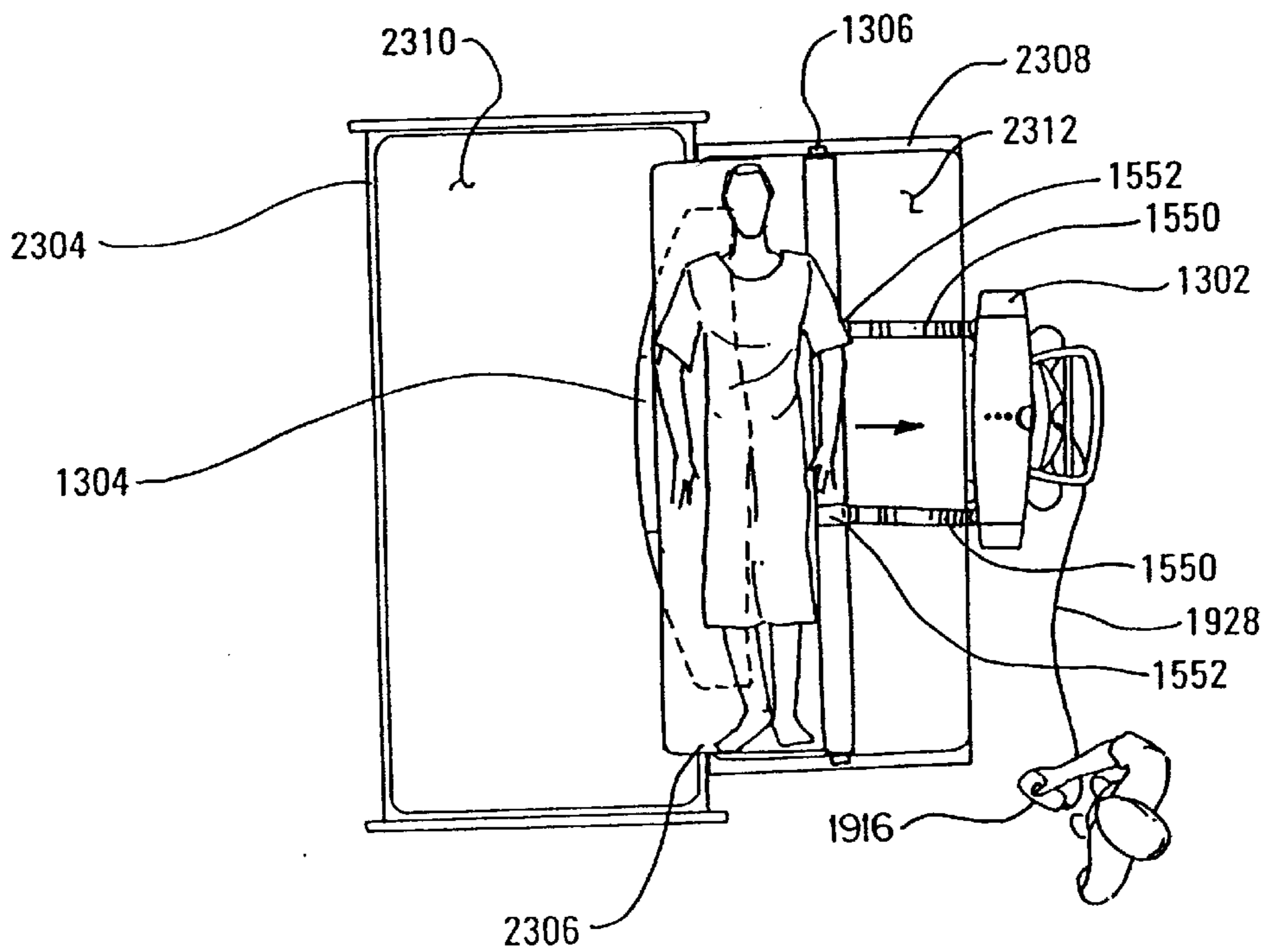


FIG. 131

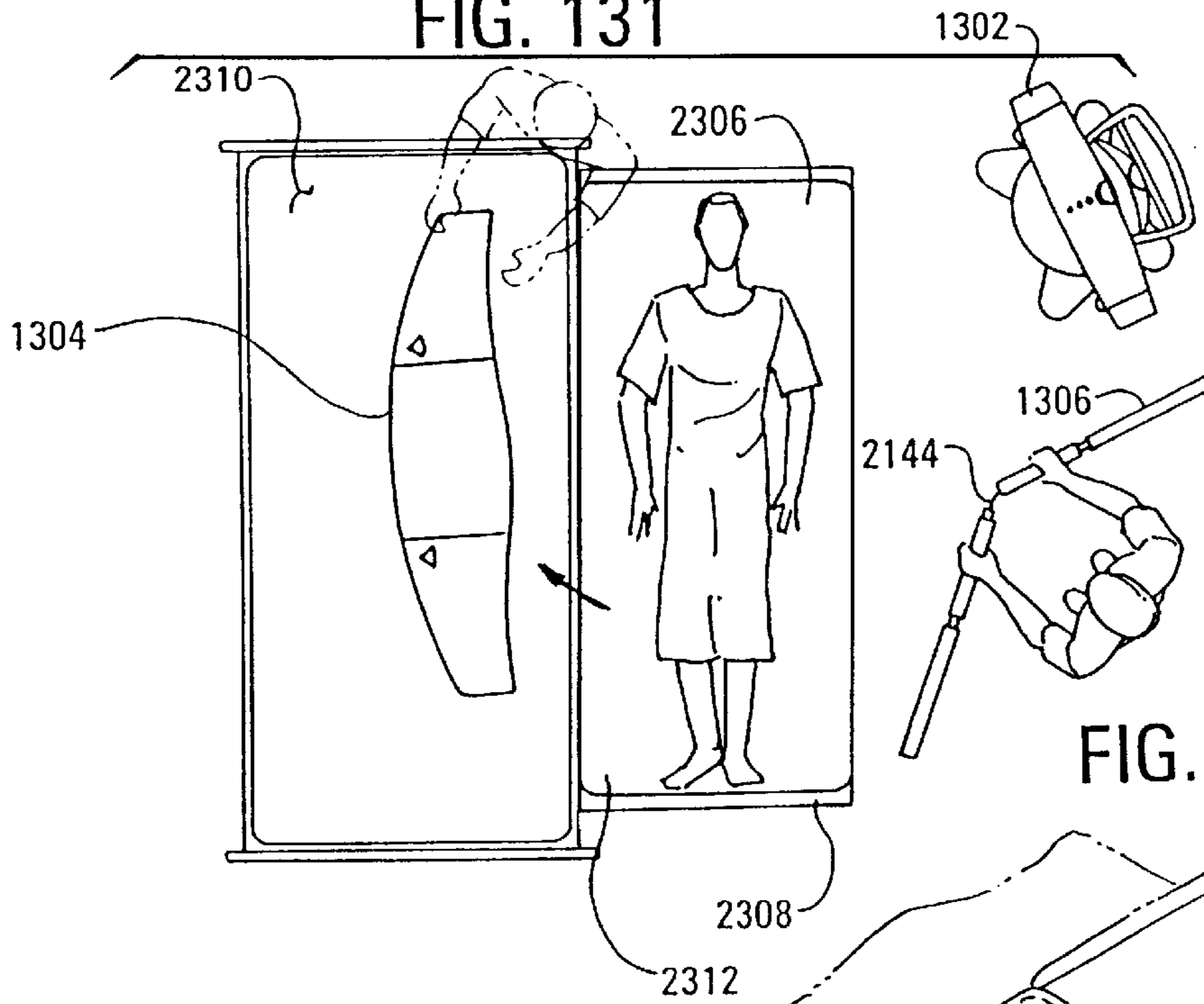


FIG. 133

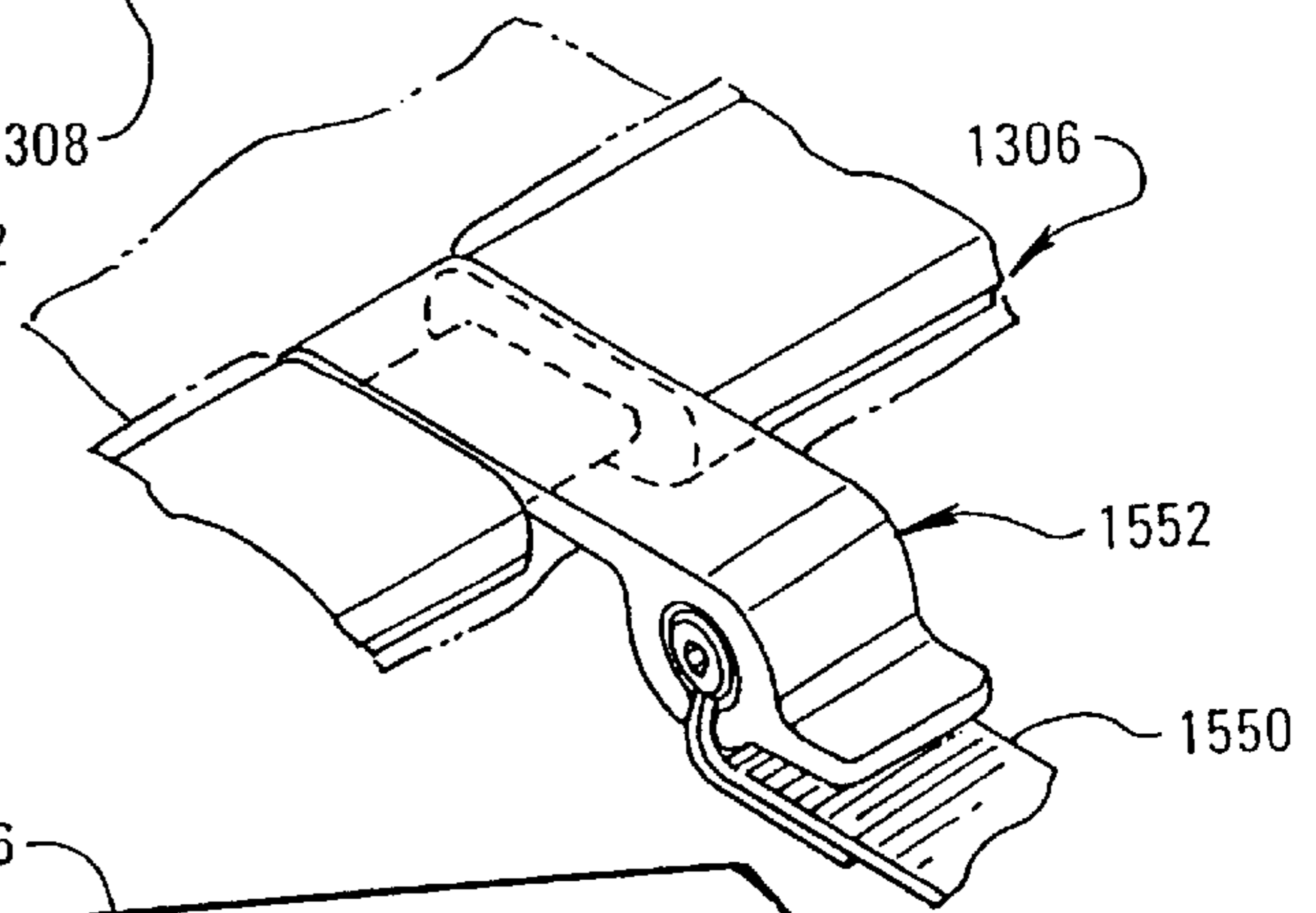


FIG. 132

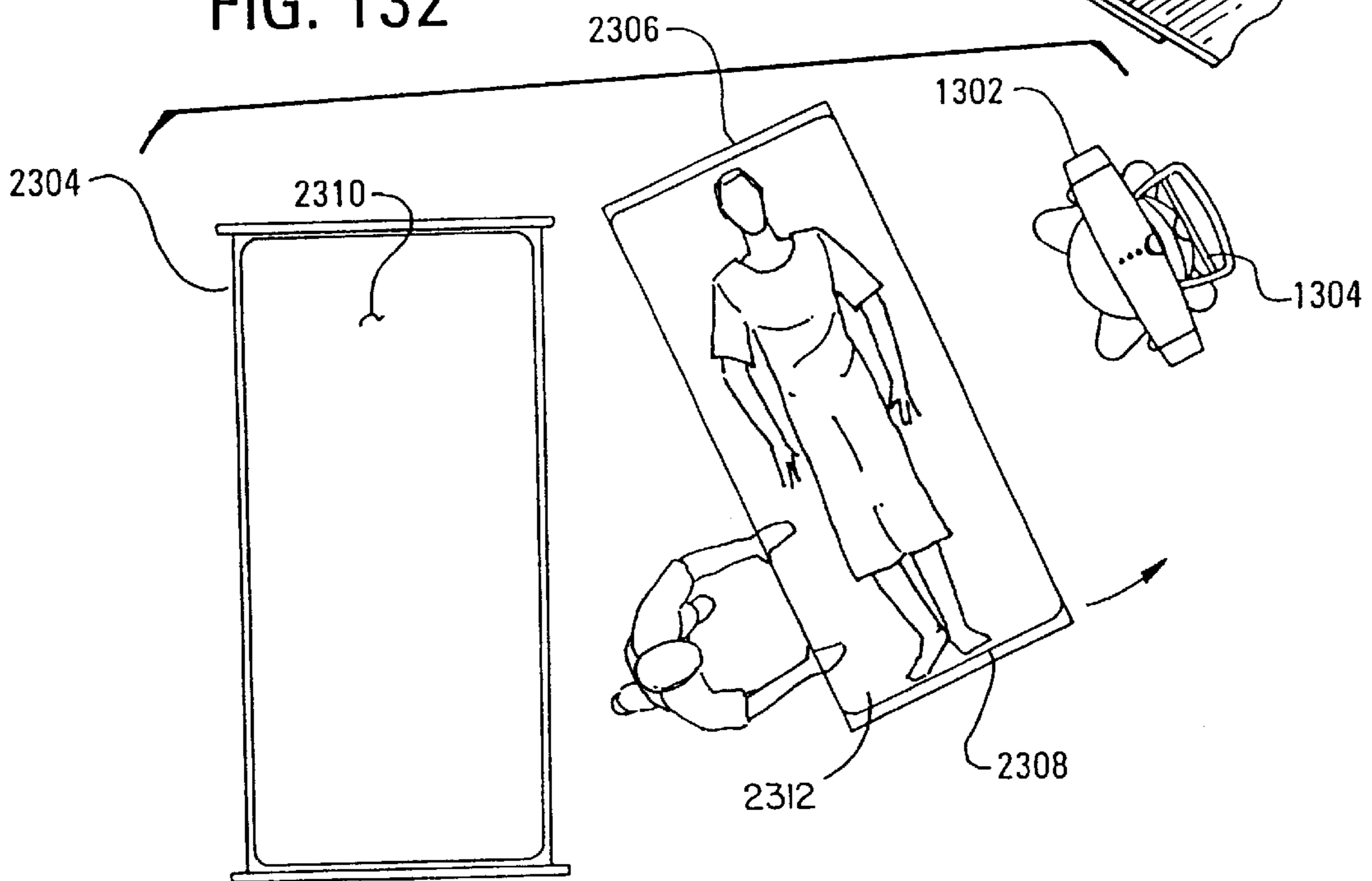






FIG. 135

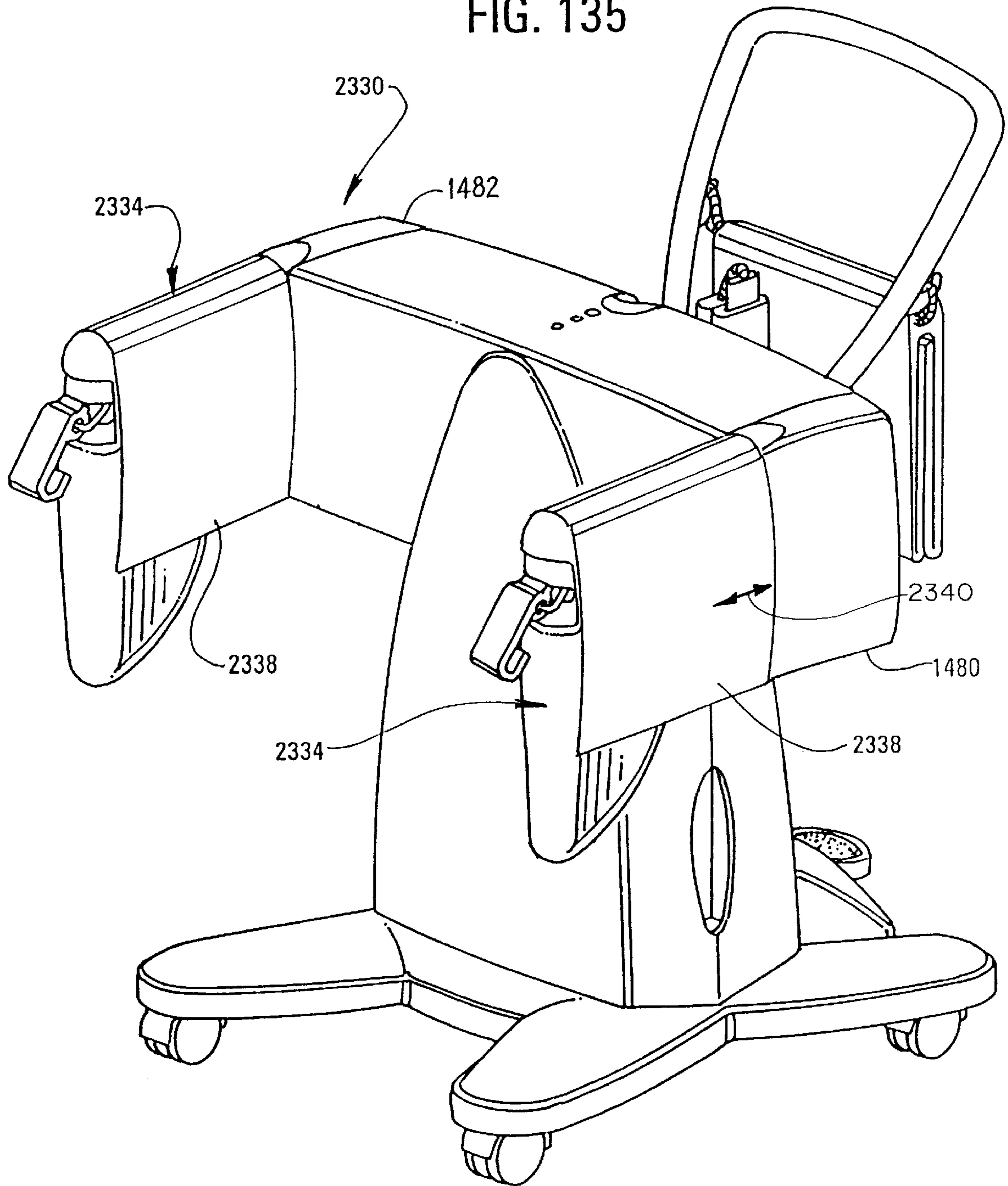
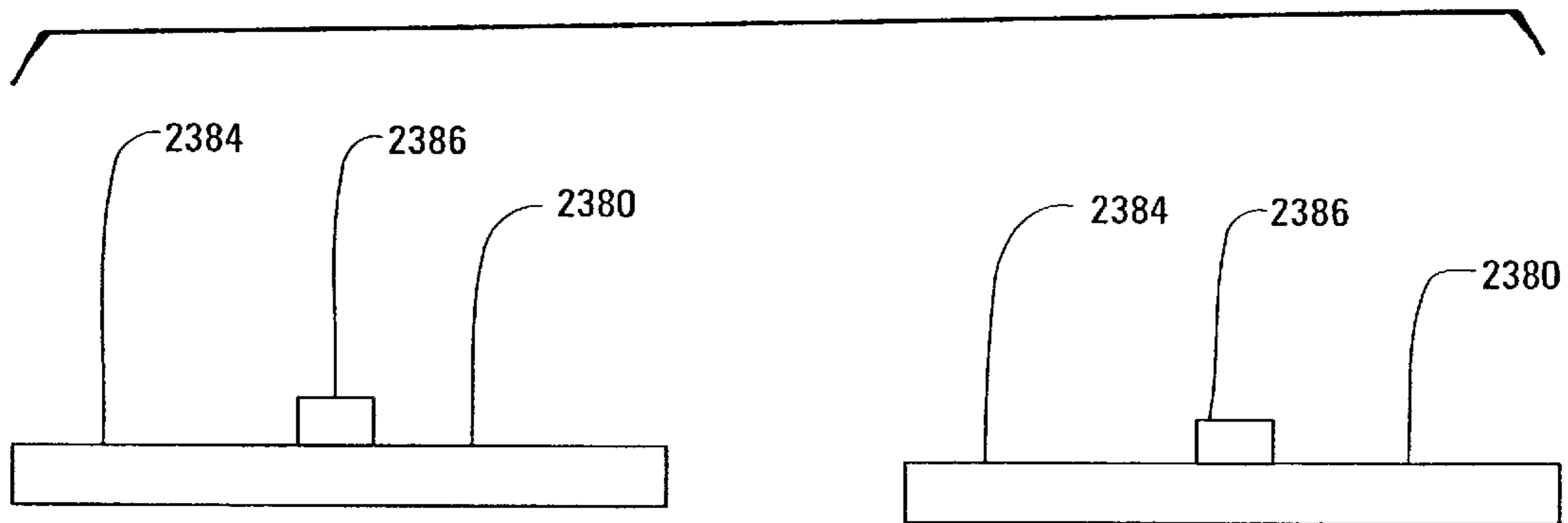
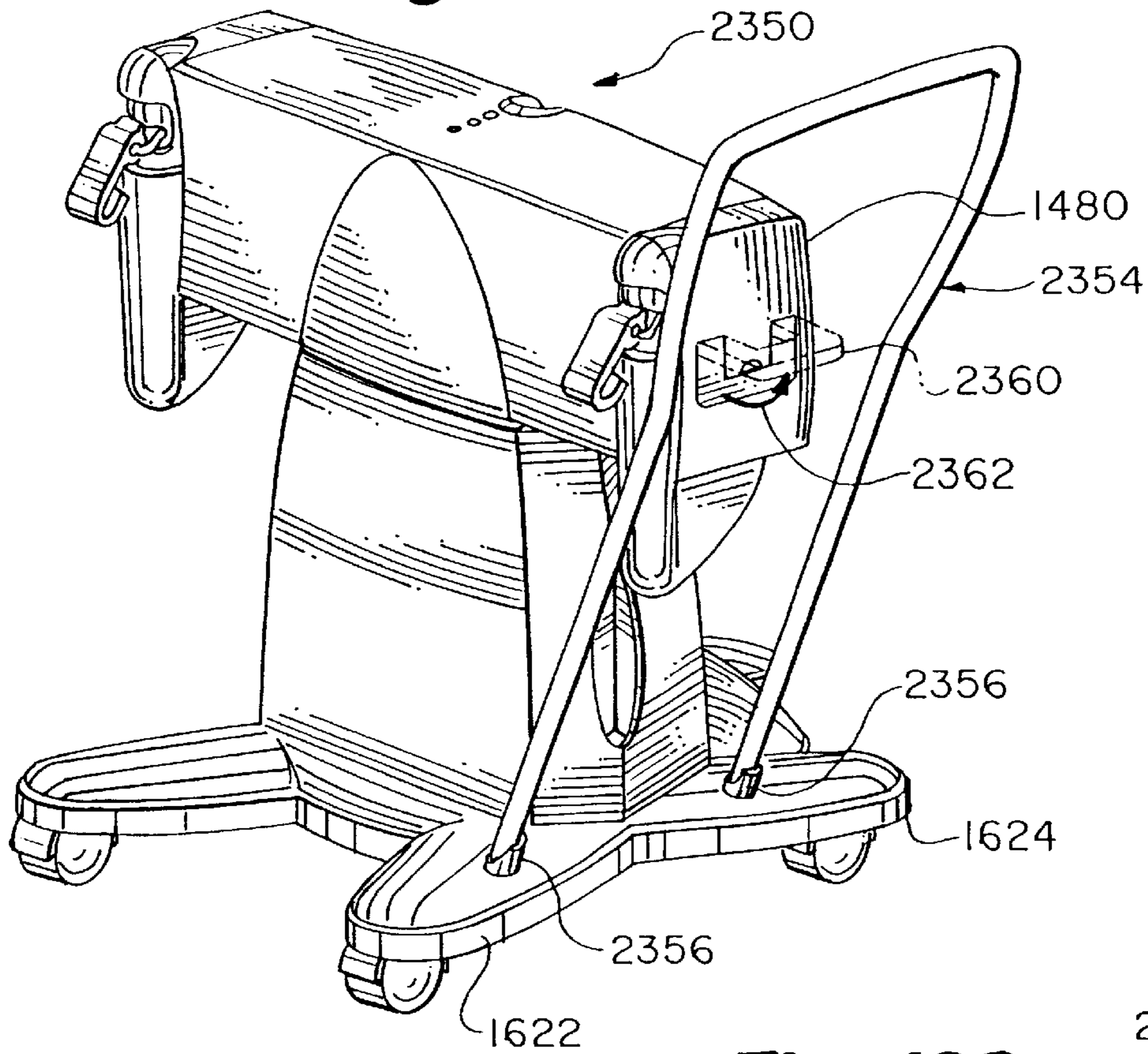


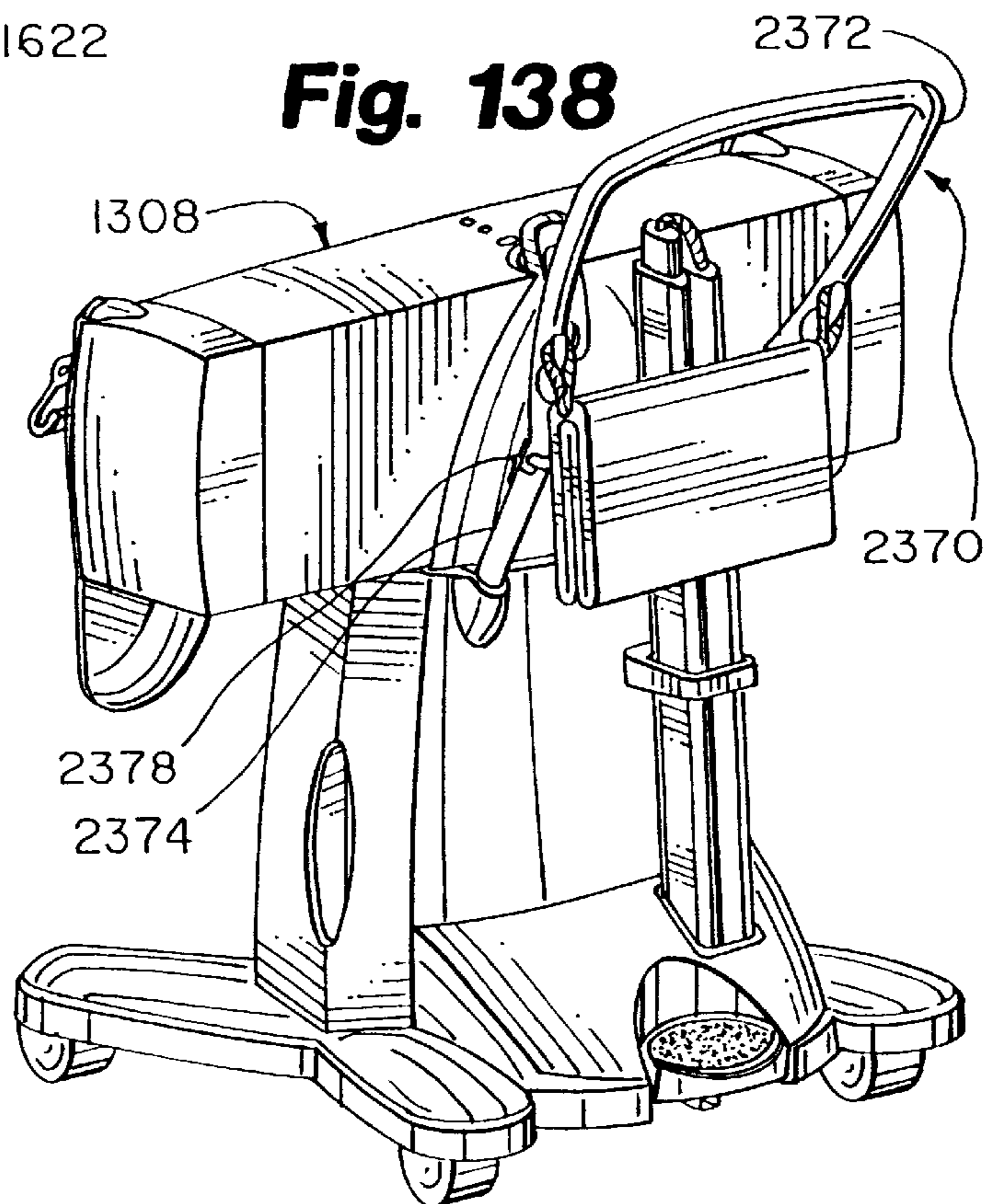
FIG. 136



**Fig. 137**

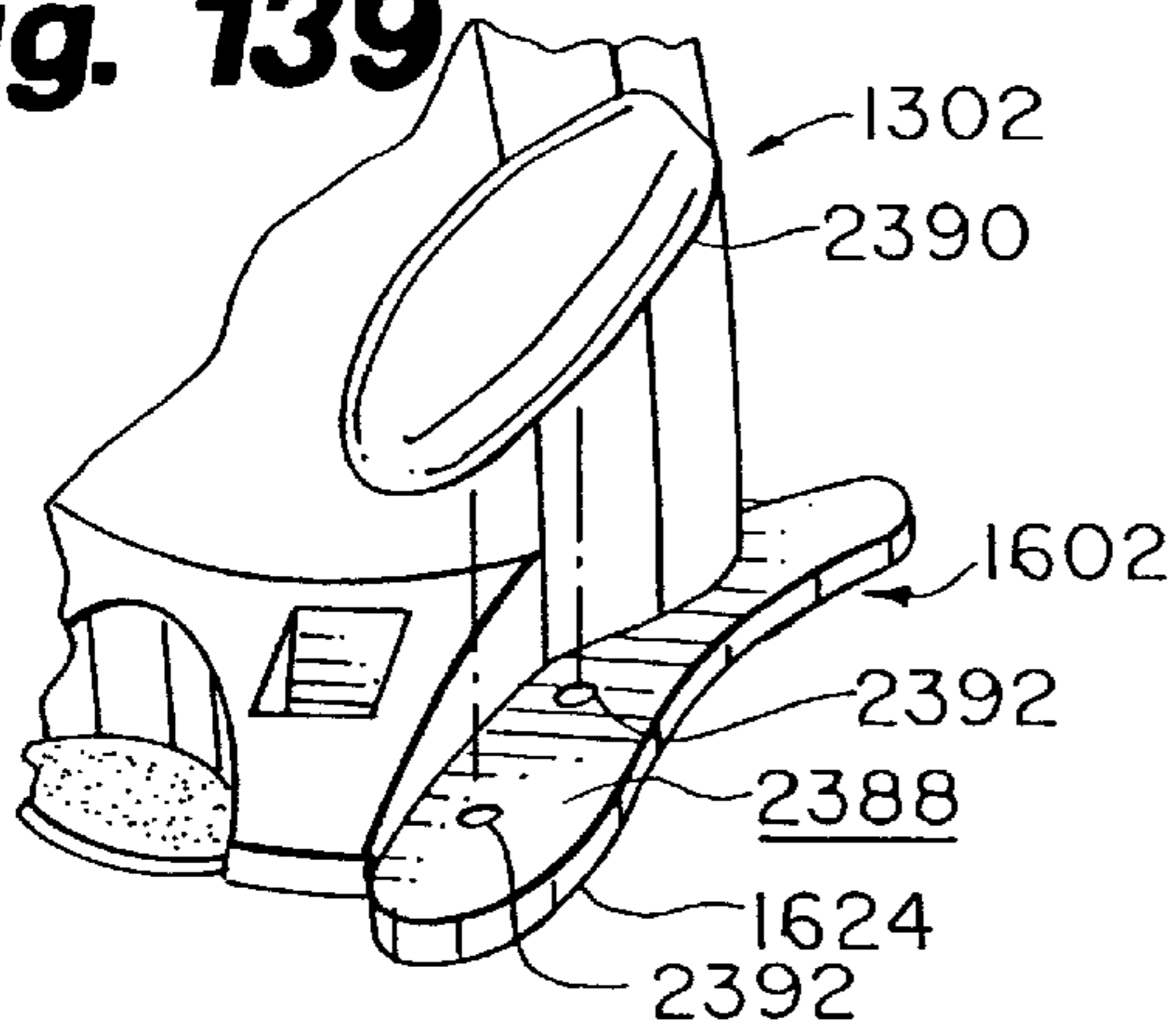


**Fig. 138**

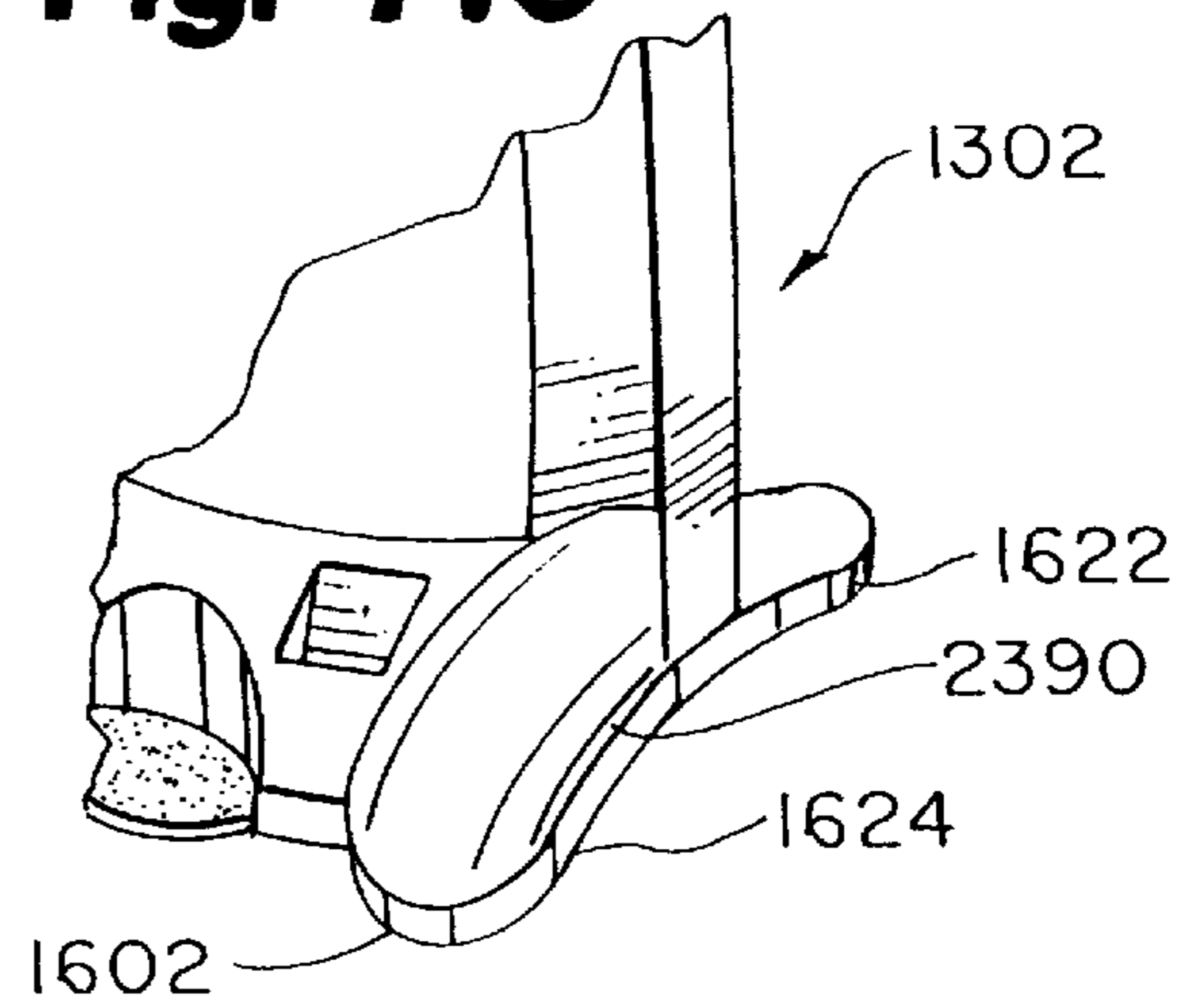




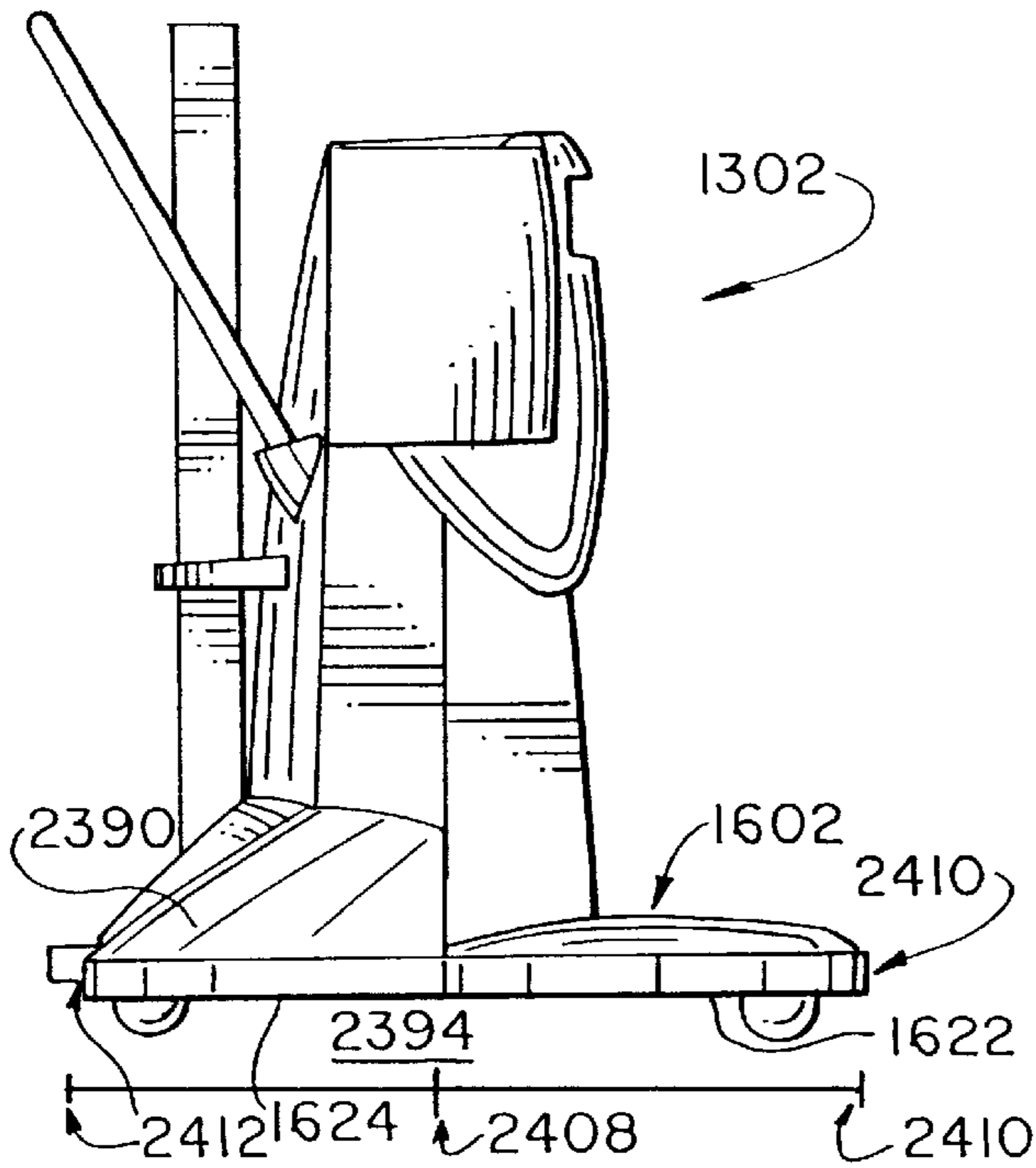
**Fig. 139**



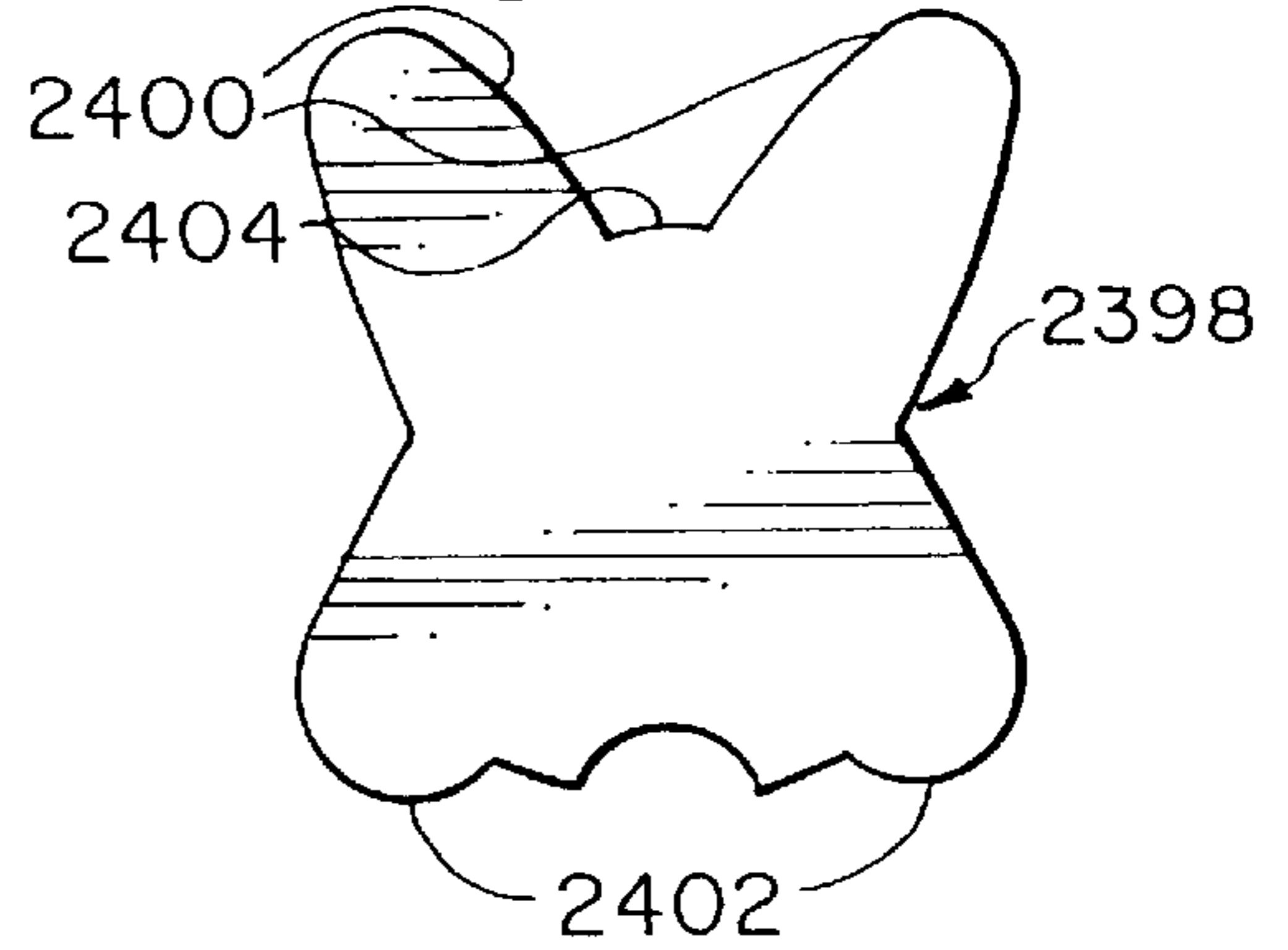
**Fig. 140**



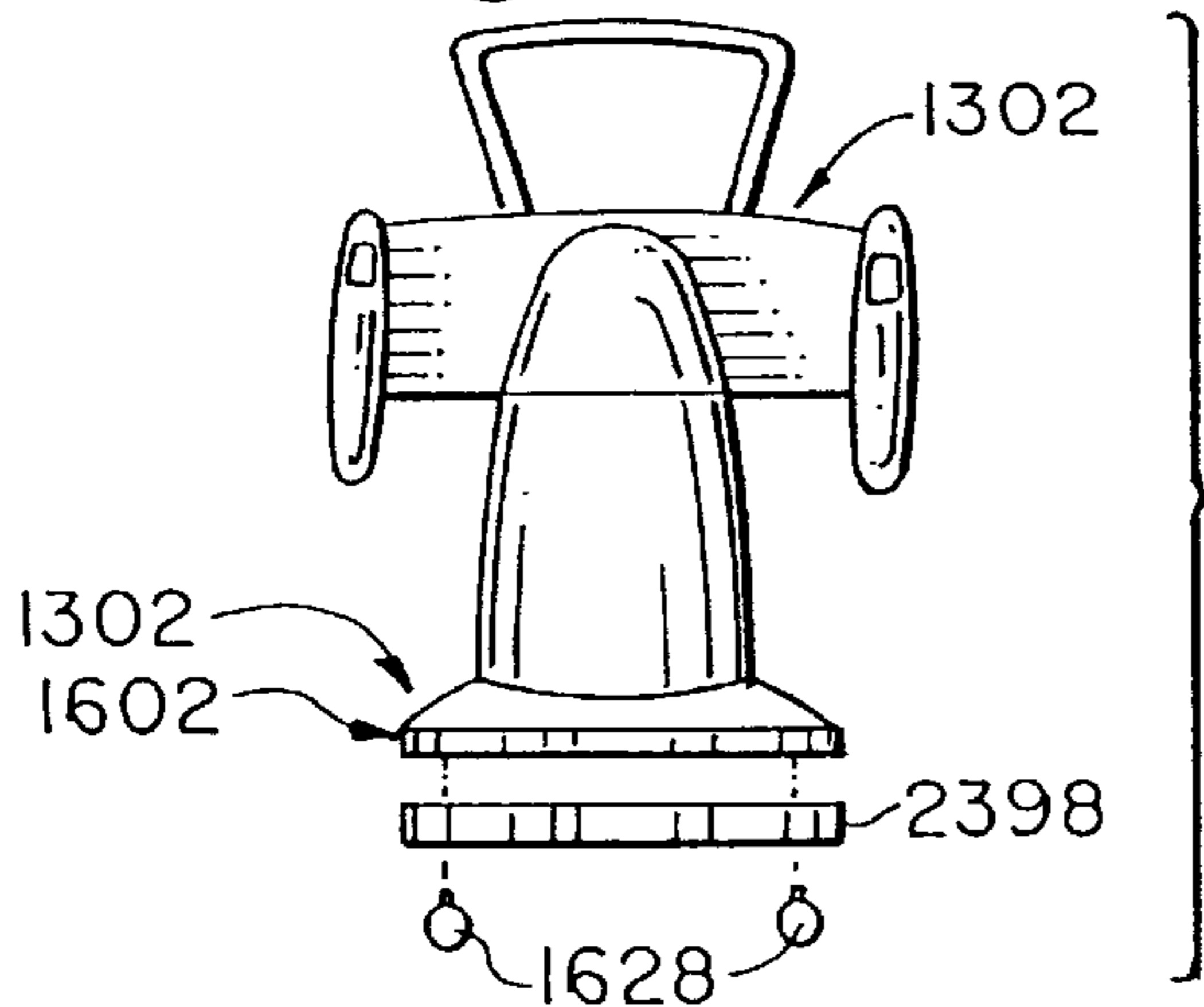
**Fig. 141**



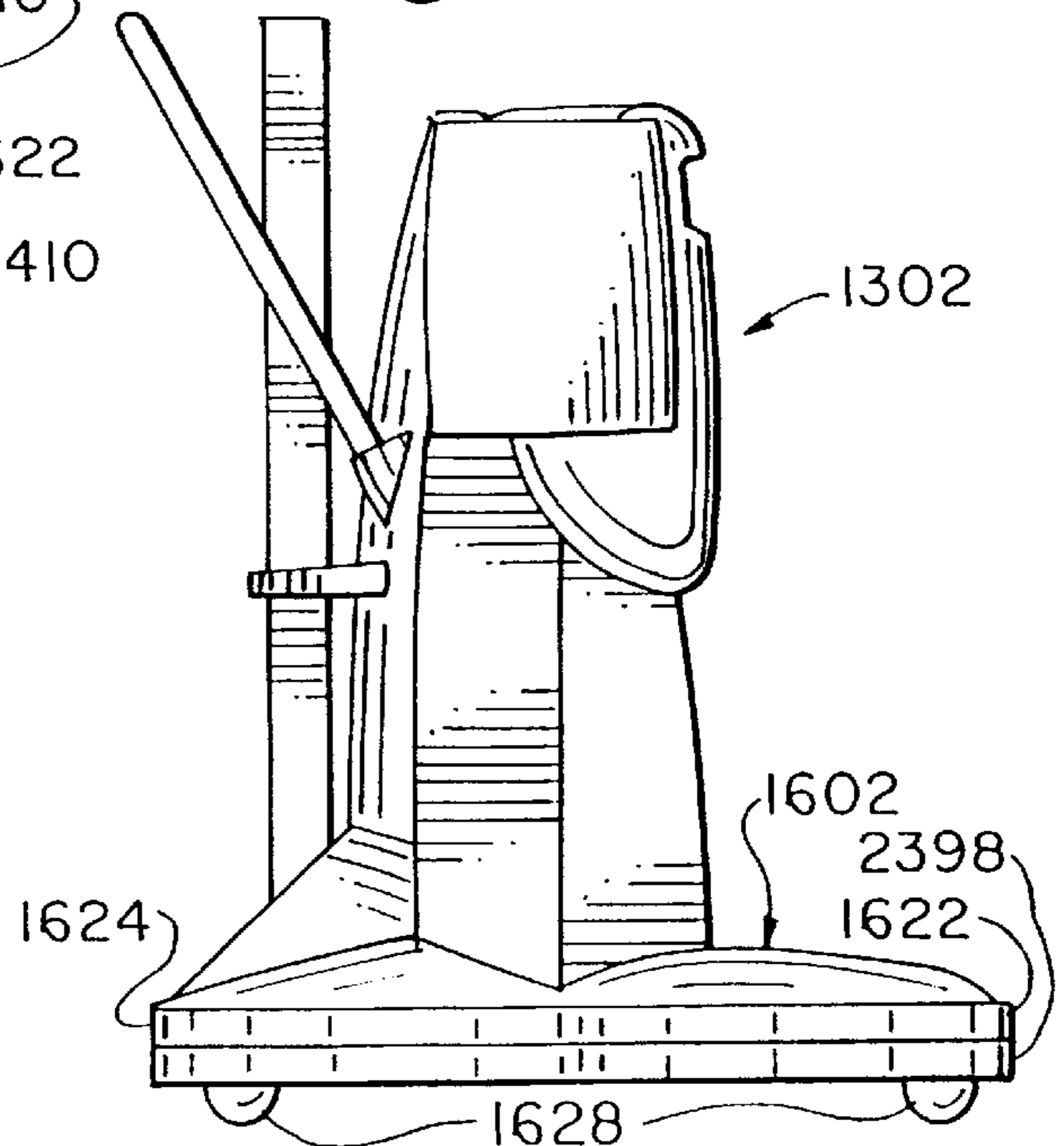
**Fig. 142**



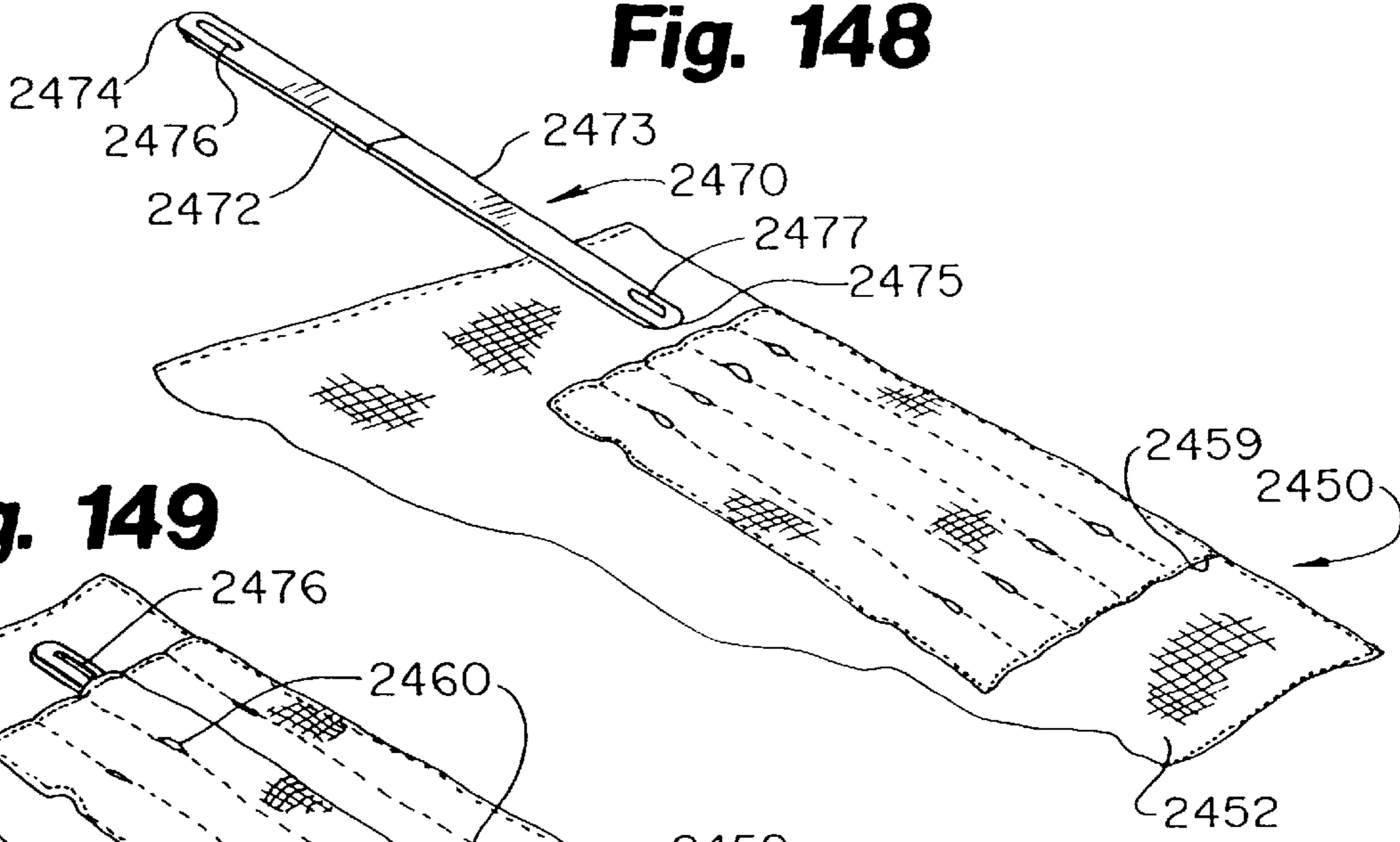
**Fig. 143**



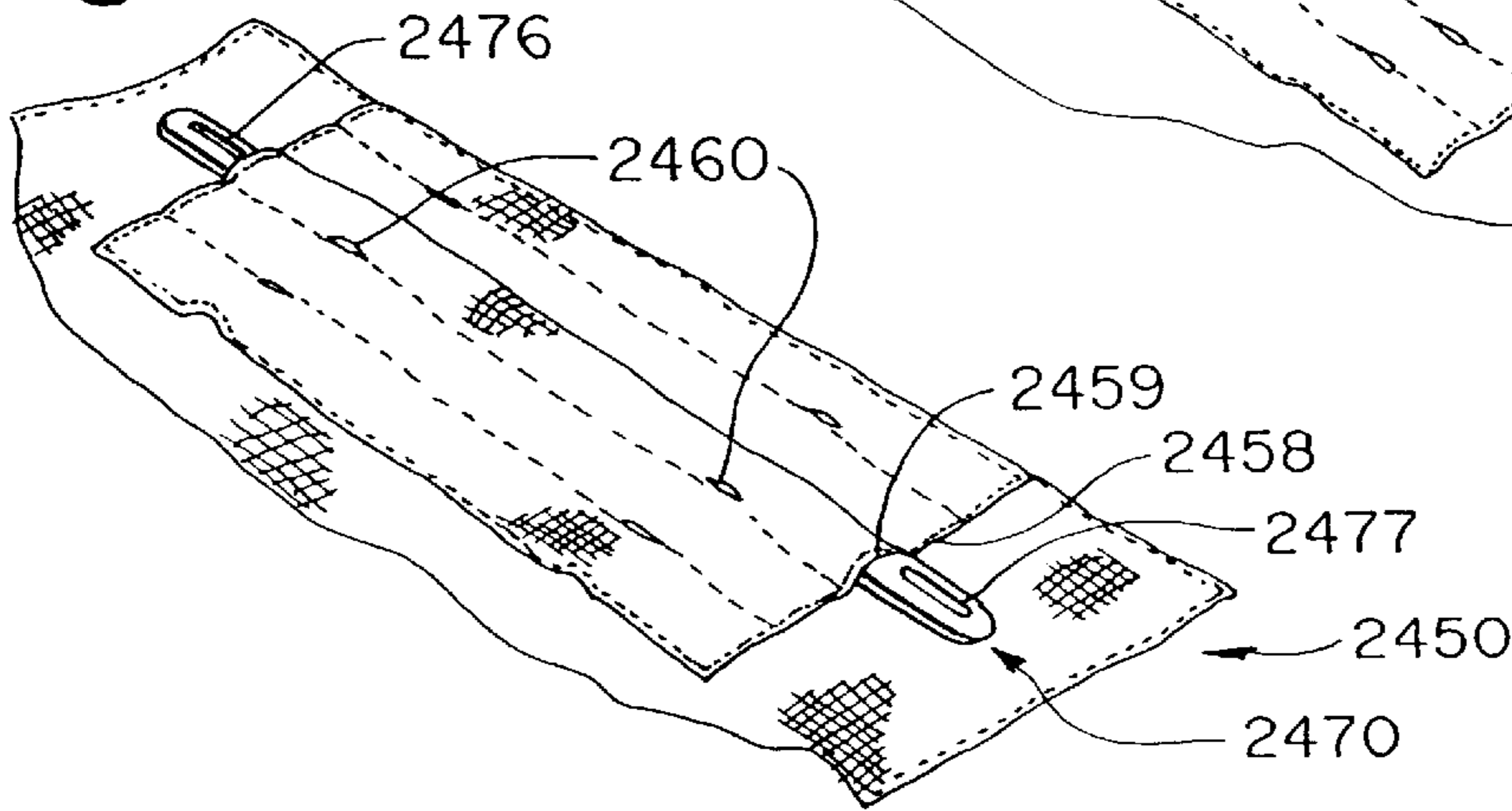
**Fig. 144**



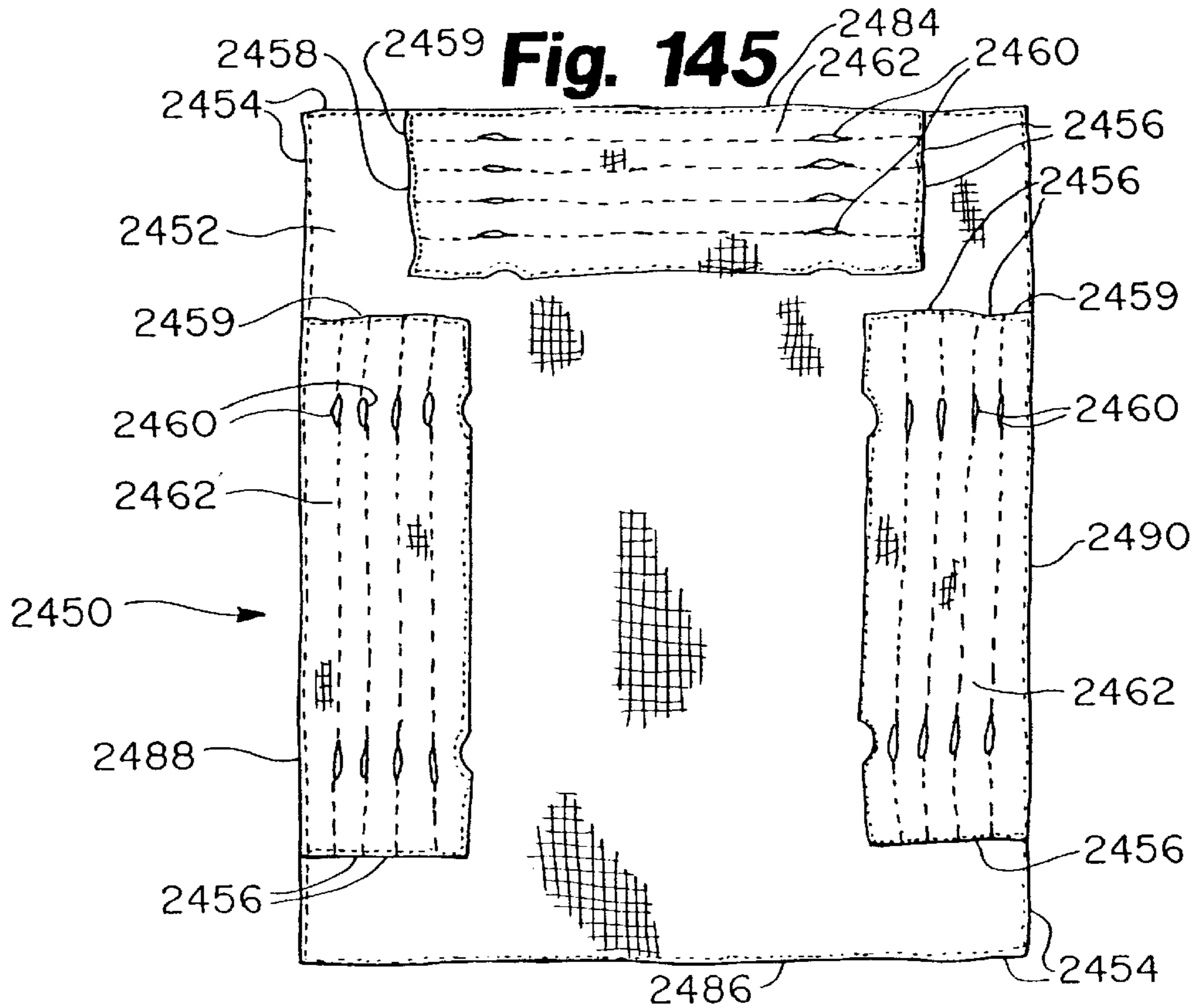
**Fig. 148**

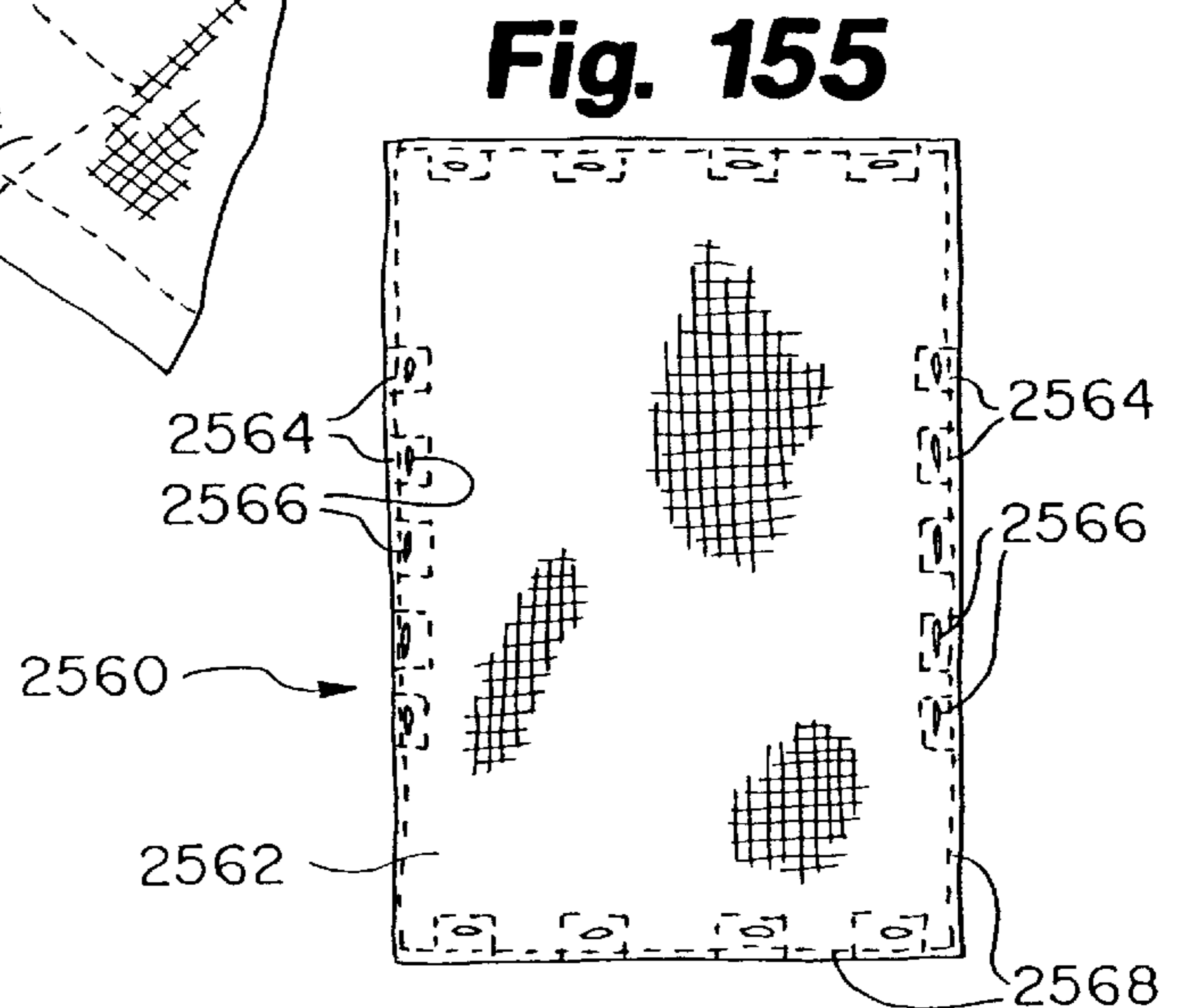
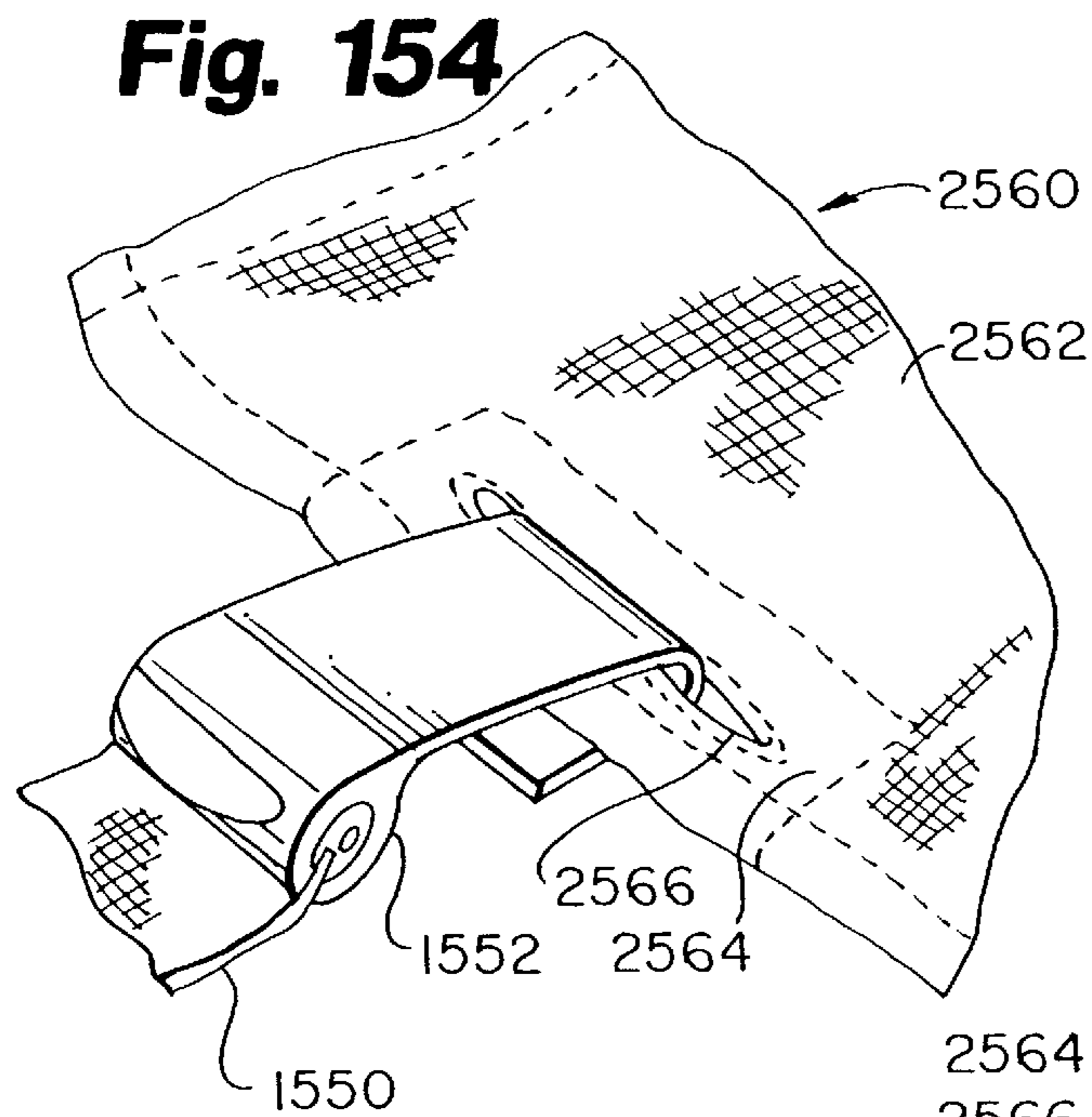
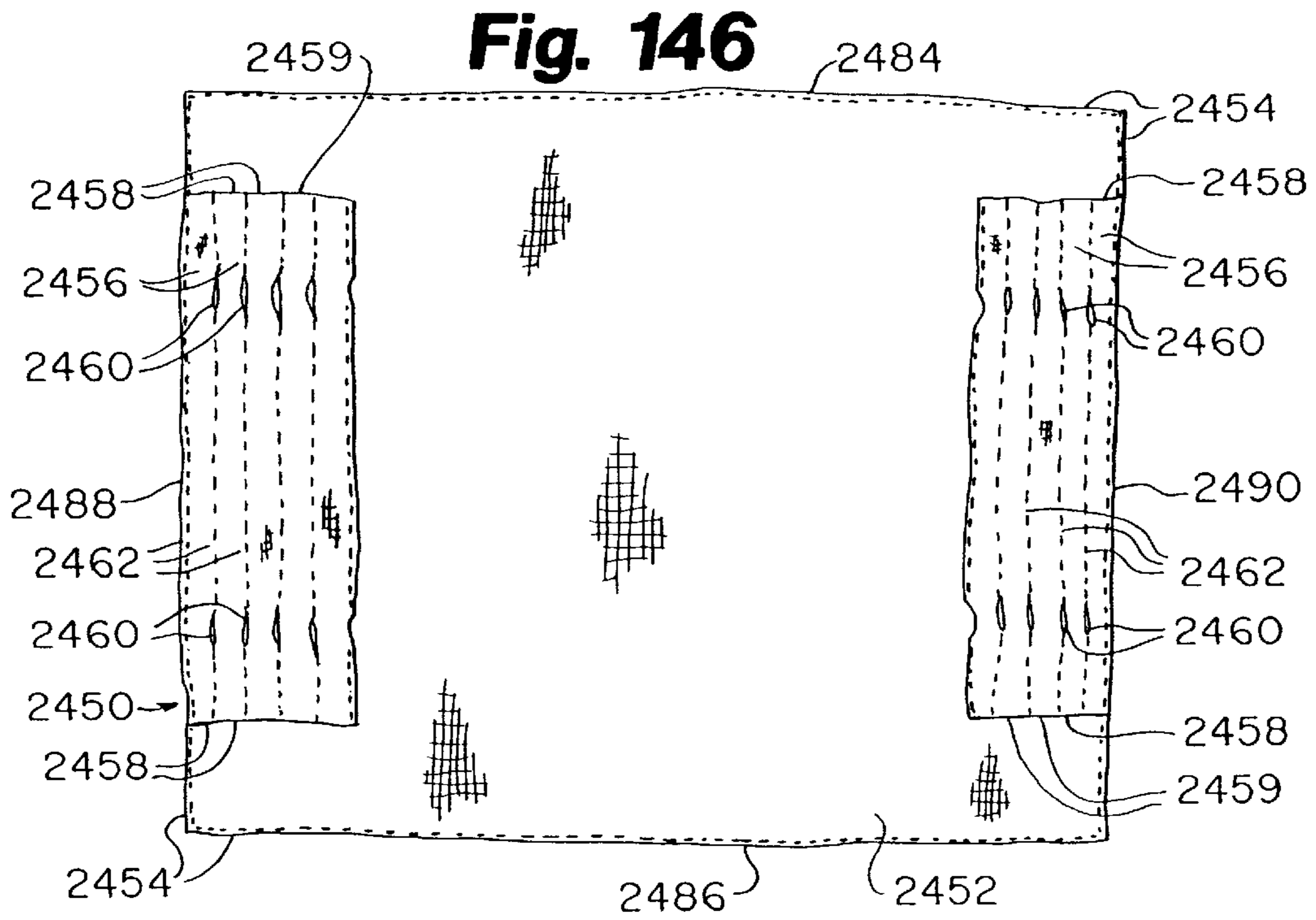


**Fig. 149**



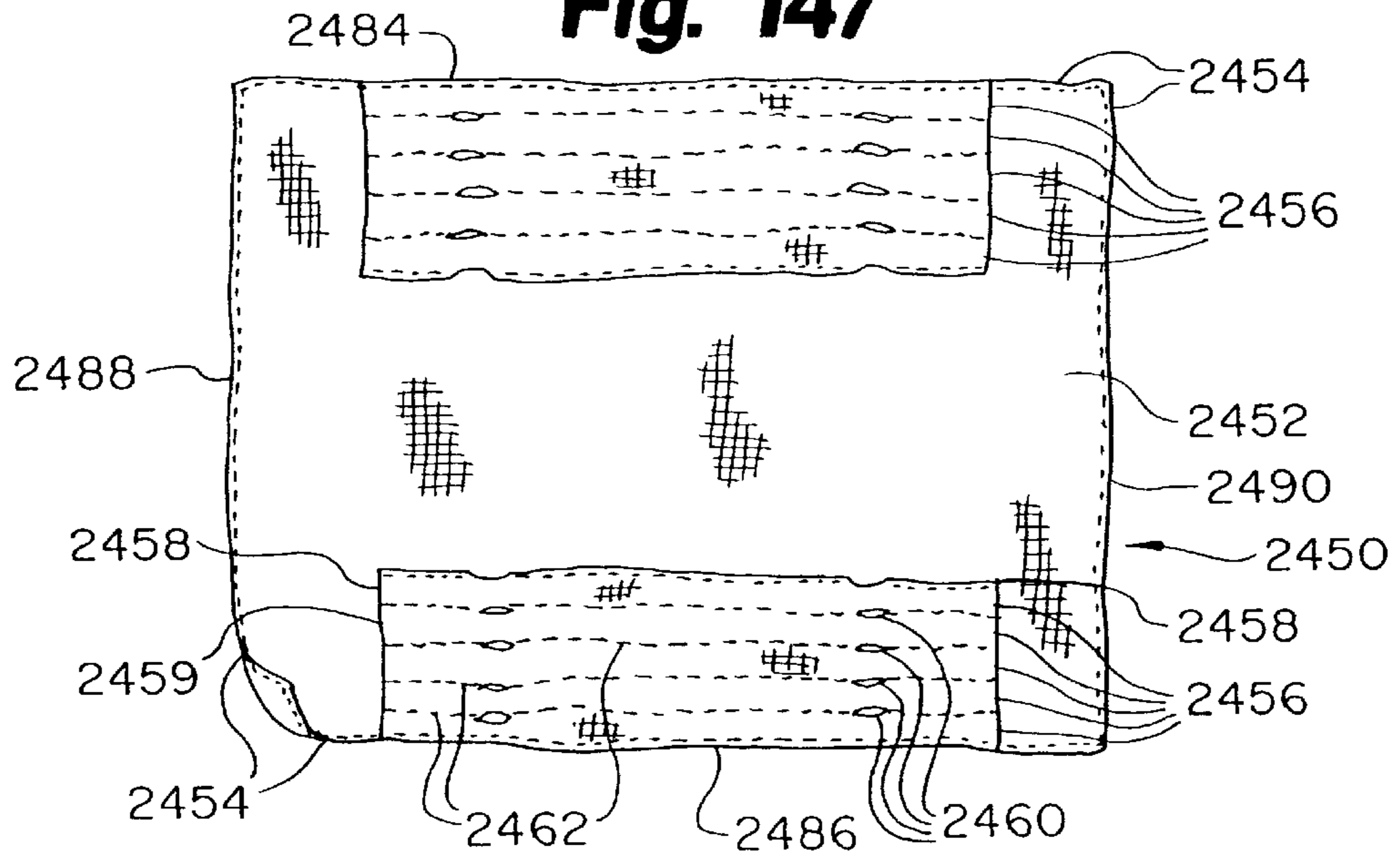
**Fig. 145**



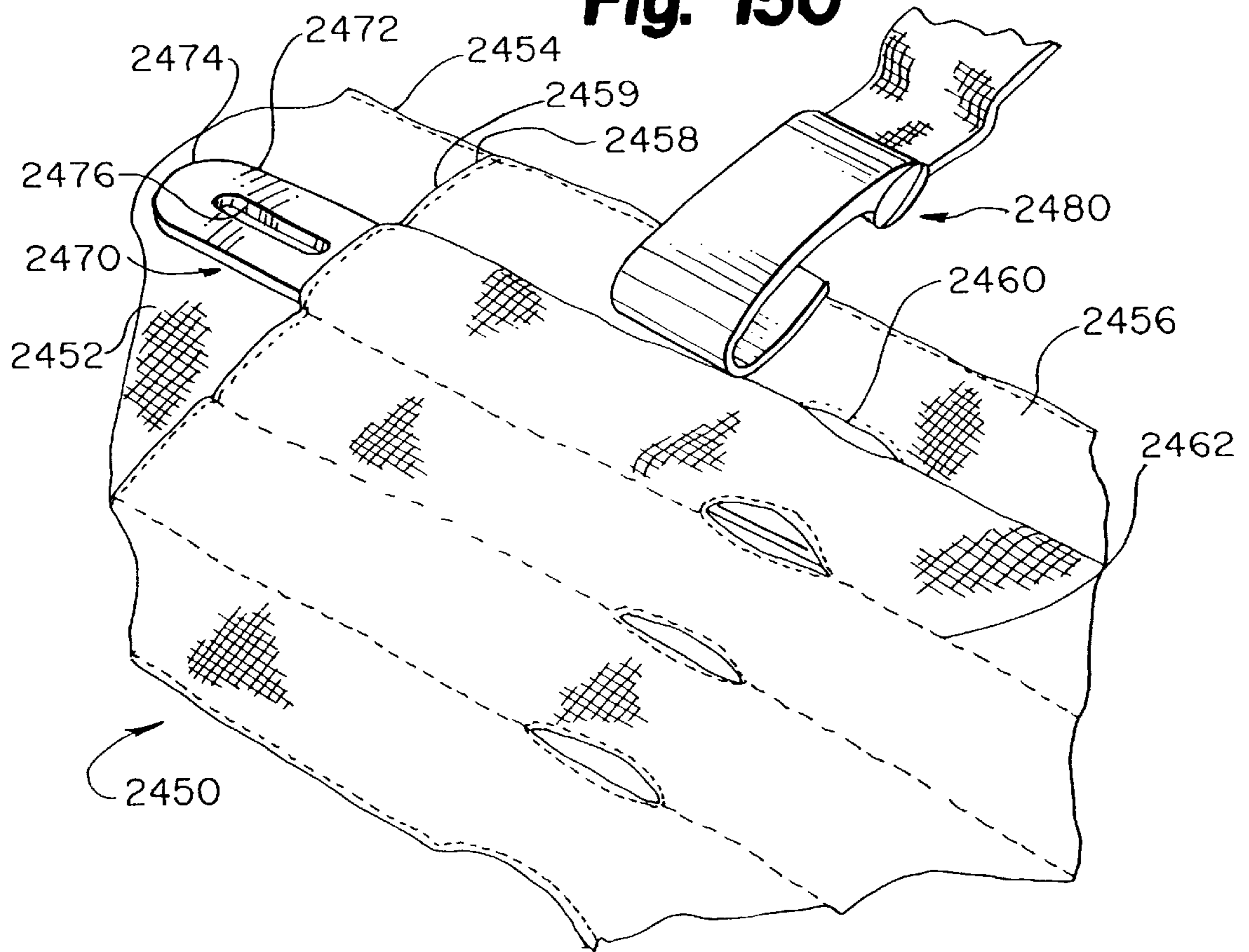




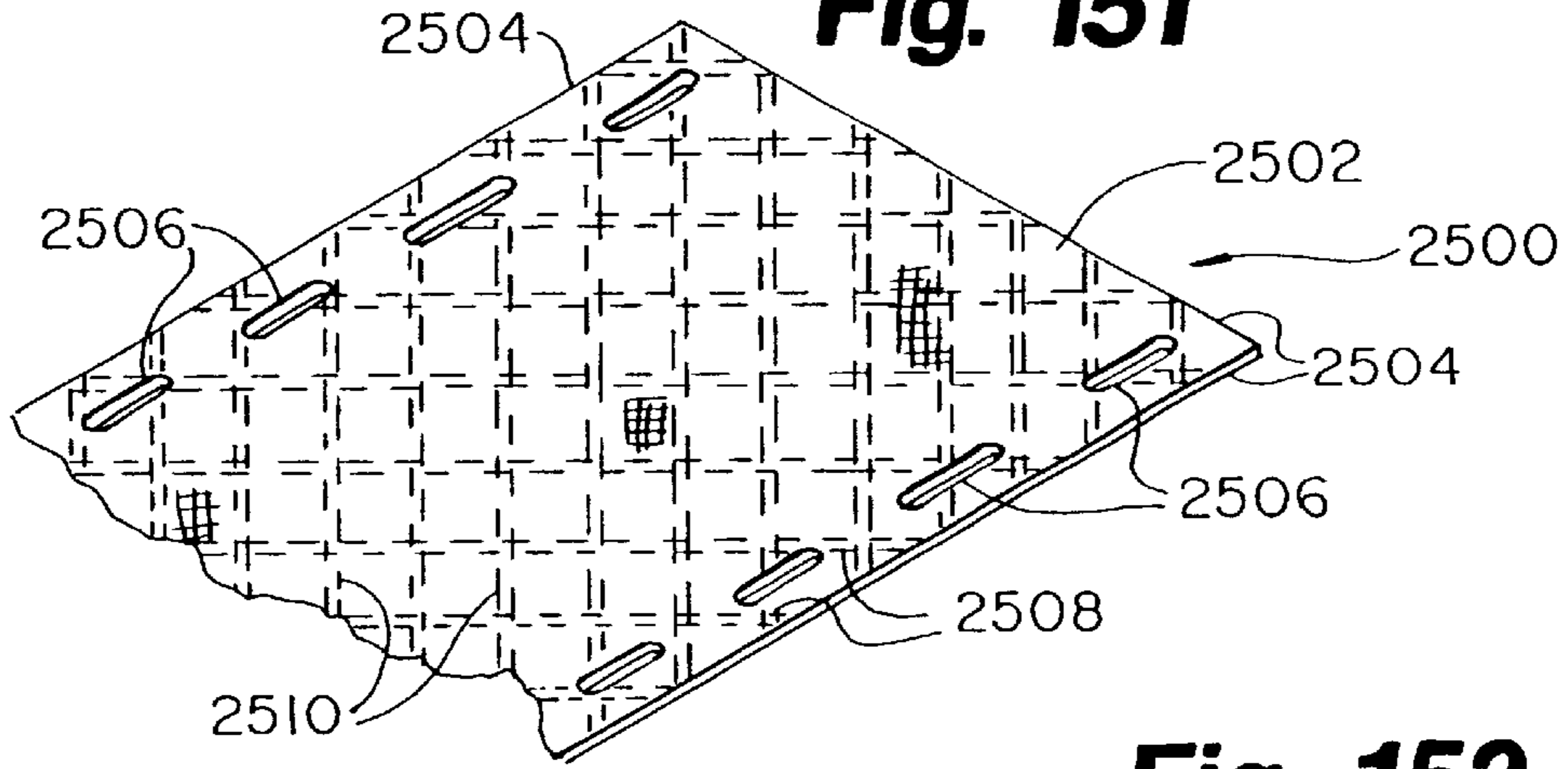
**Fig. 147**



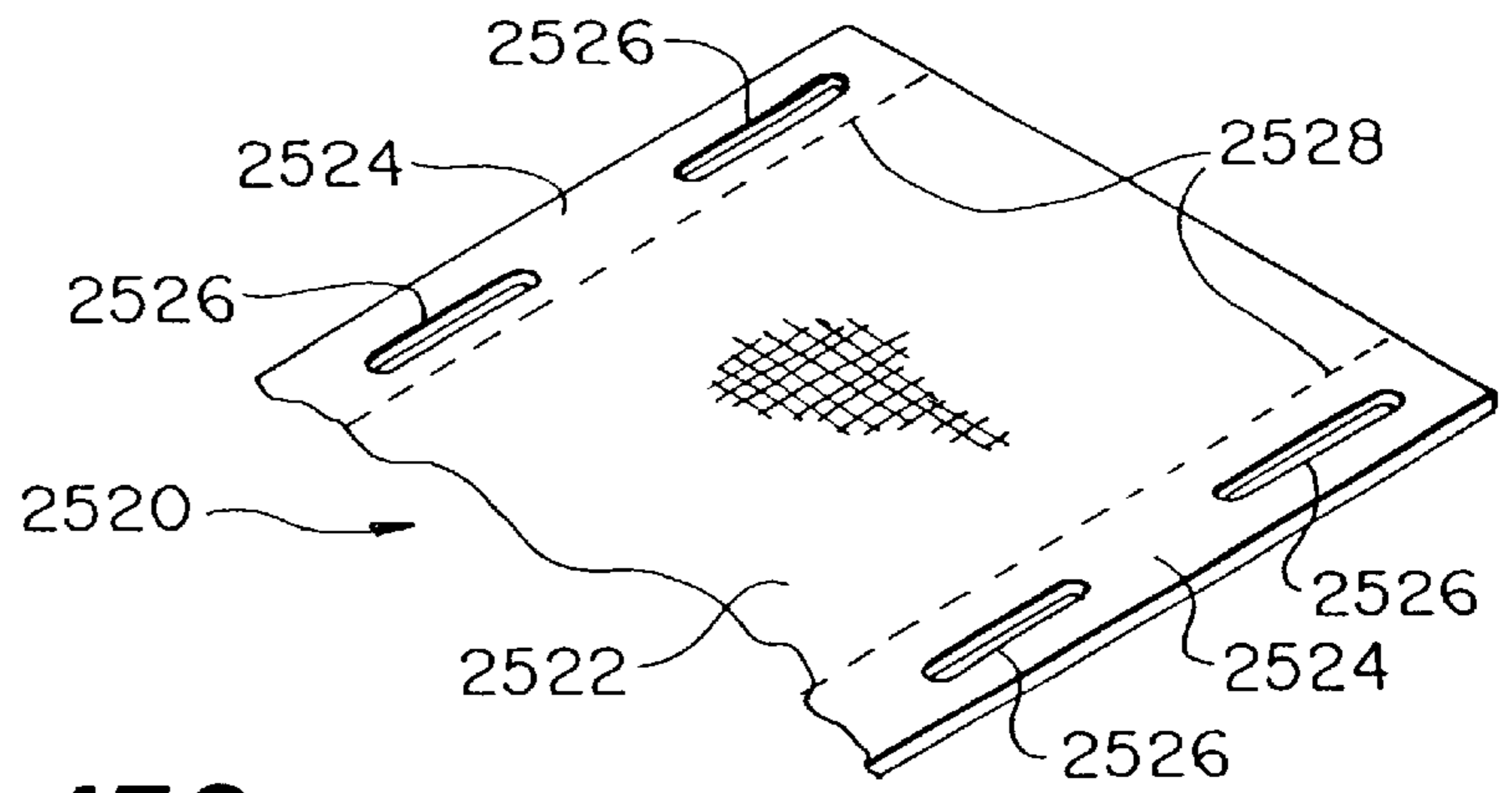
**Fig. 150**



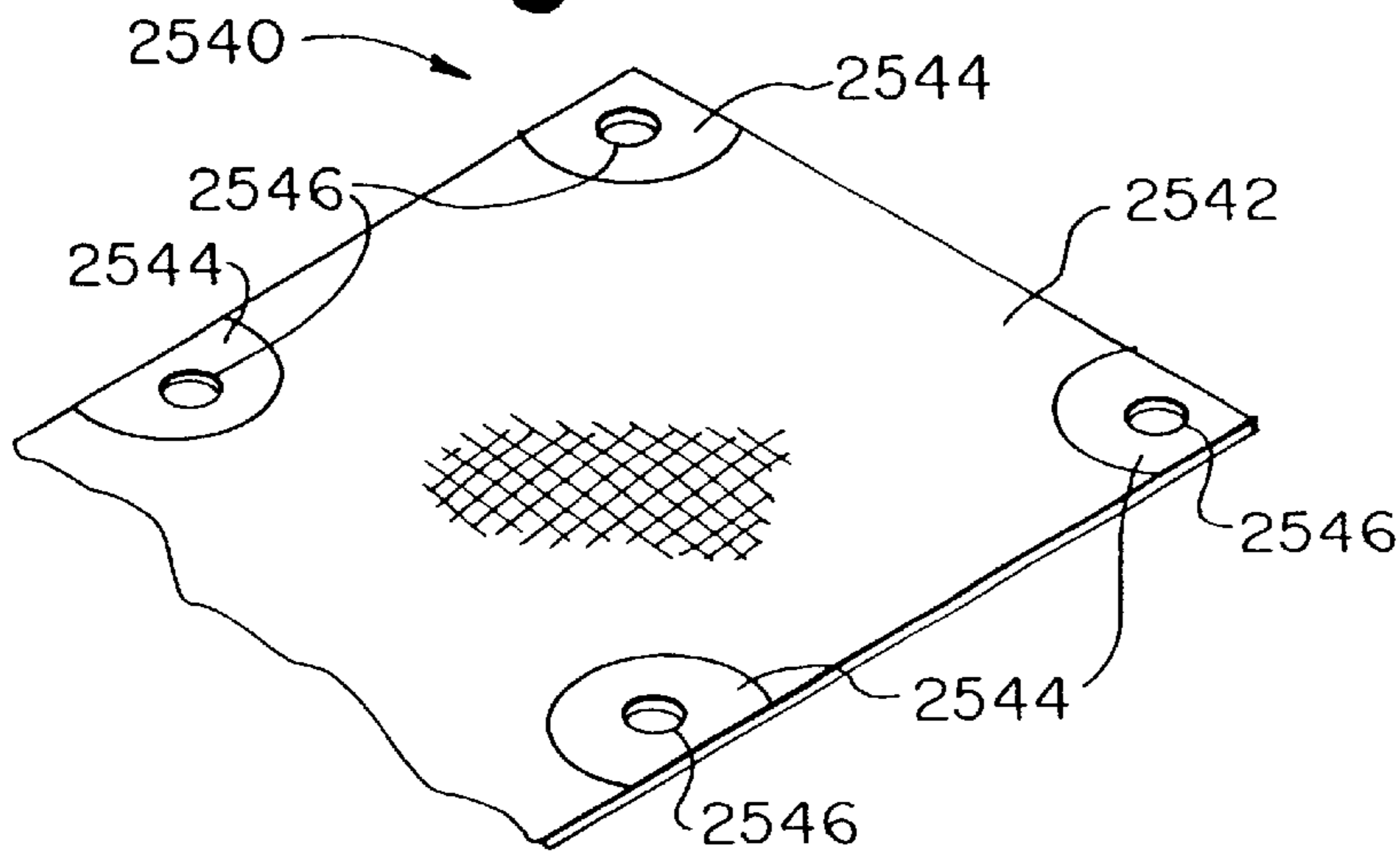
**Fig. 151**



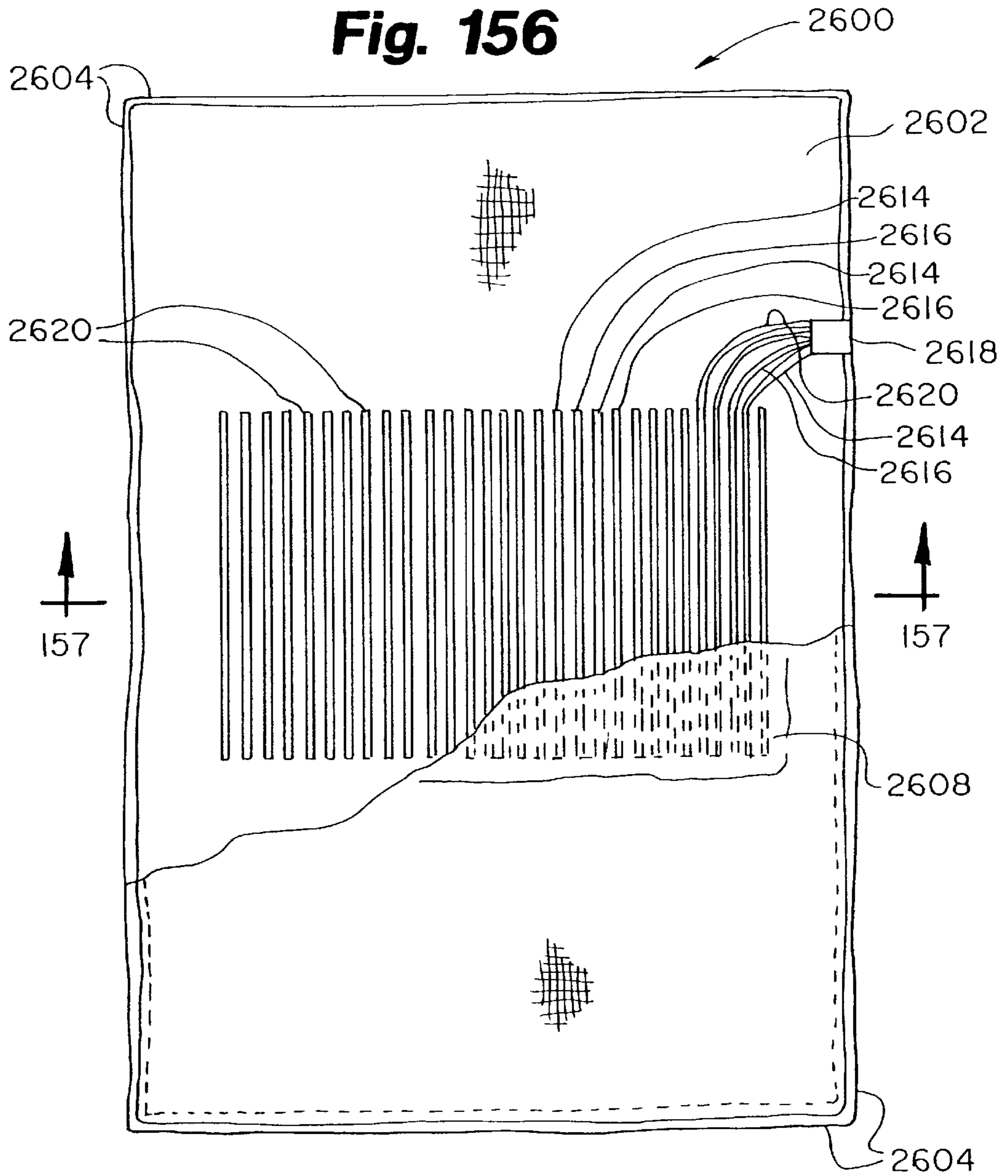
**Fig. 152**



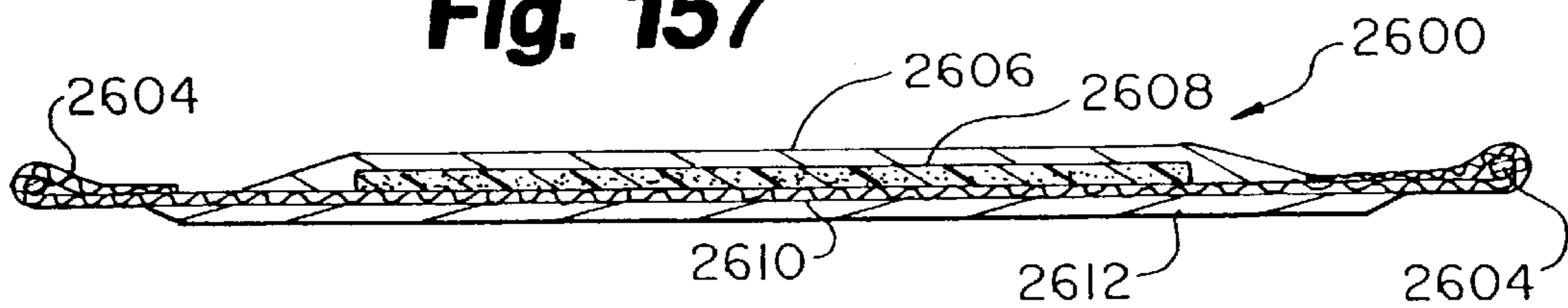
**Fig. 153**



**Fig. 156**

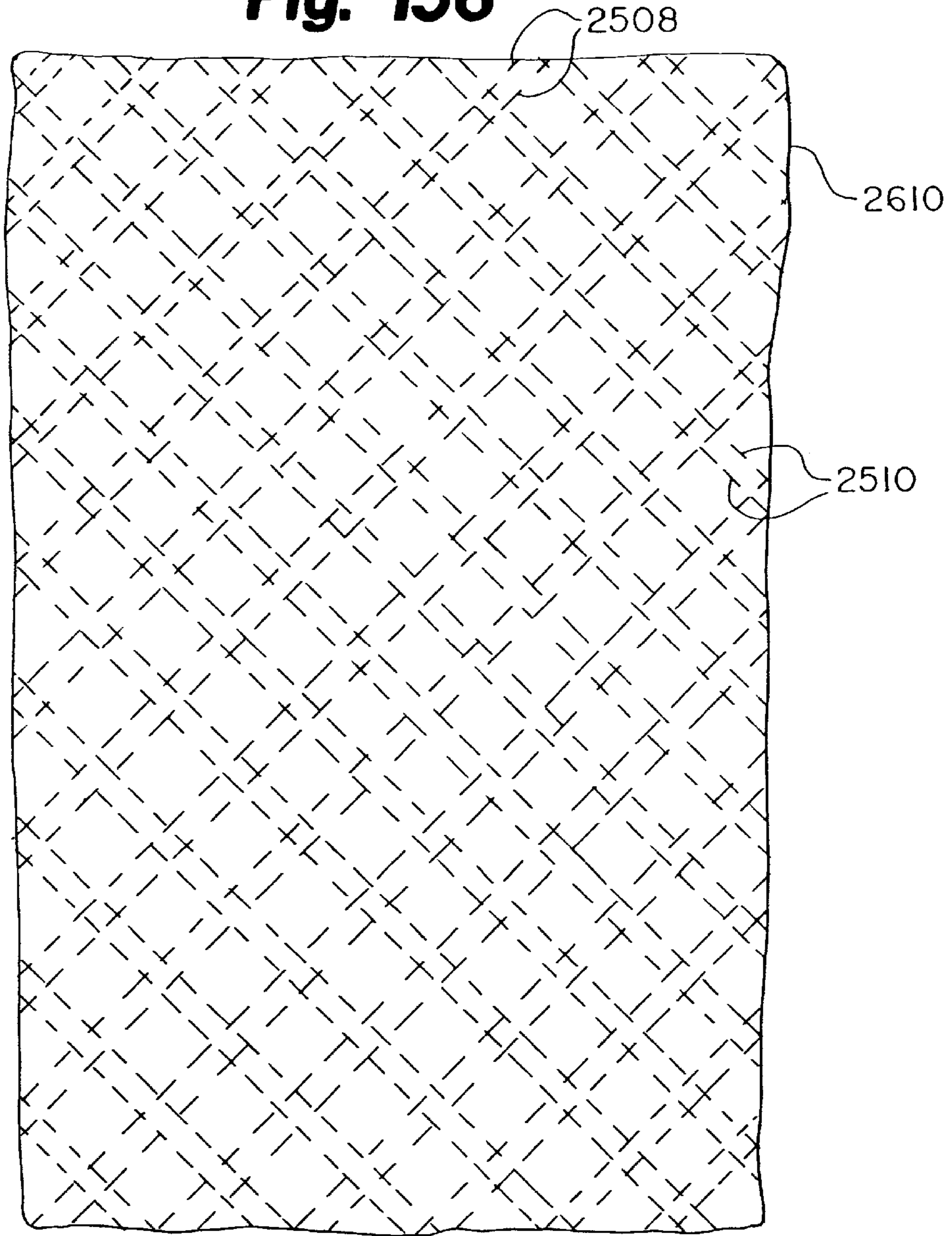


**Fig. 157**

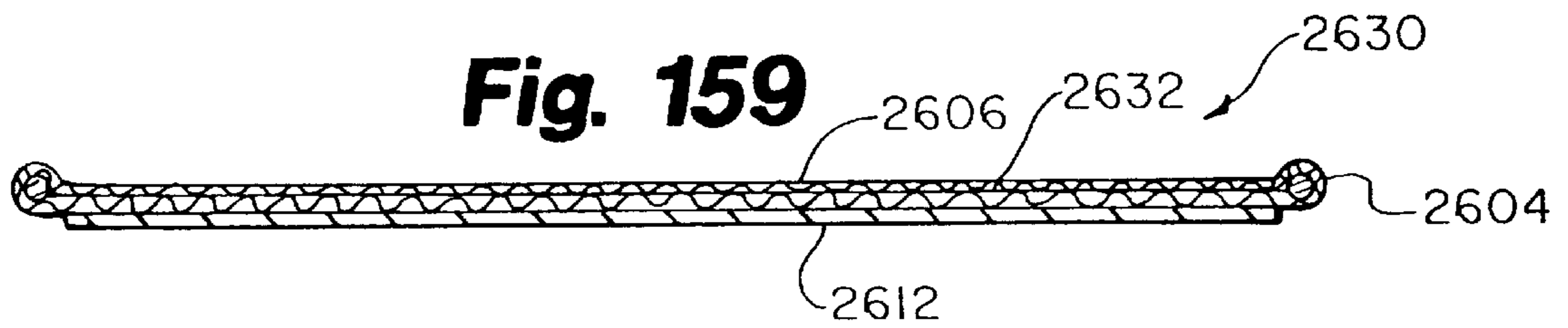




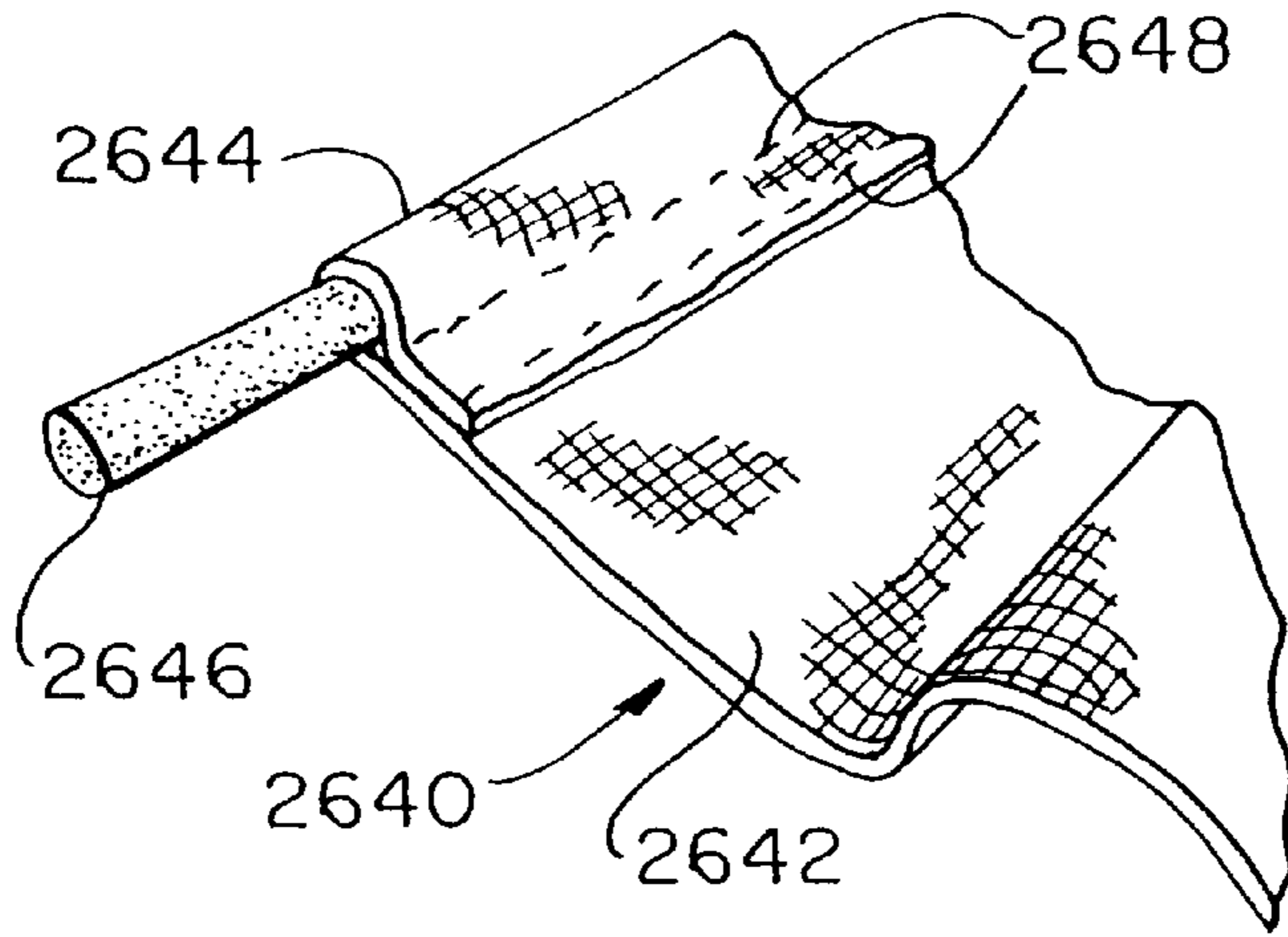
**Fig. 158**



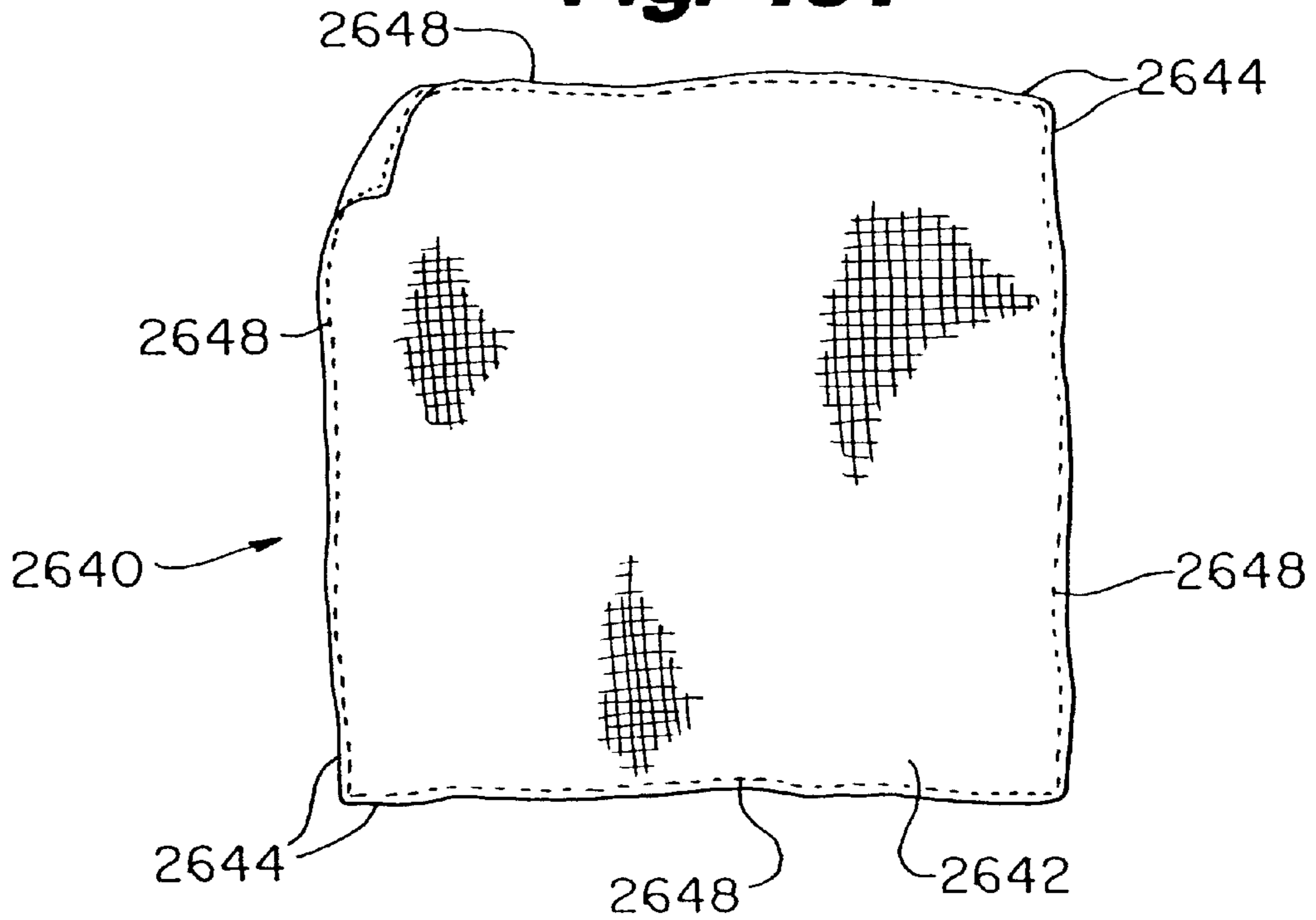
**Fig. 159**



**Fig. 160**



**Fig. 161**





## PATIENT TRANSFER AND REPOSITIONING SYSTEM

### CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. patent application Ser. No. 09/057,139, filed Apr. 8, 1998, which is a continuation-in-part of U.S. patent application Ser. No. 08/713,412, filed Sep. 13, 1996 now U.S. Pat. No. 5,890,238, which is a continuation-in-part of U.S. patent application Ser. No. 08/527,519, filed Sep. 13, 1995 and now U.S. Pat. No. 5,737,781, all hereby incorporated by reference. U.S. patent application Ser. No. 09/057,139 claimed the benefit of U.S. Provisional Patent Application No. 60/043,208, filed Apr. 8, 1997. This Application claims the benefit of U.S. Provisional Application No. 60/084,519, filed May 7, 1998 and U.S. Provisional Patent Application Nos. 60/092,286 and 60/092,287, both filed Jul. 10, 1998, all hereby incorporated by reference.

### FIELD OF THE INVENTION

The invention relates to systems which assist in moving, transporting, repositioning, and rolling over patients who are partly or completely incapacitated. The invention more particularly relates to systems which give a single health care worker the capability to move a patient from one bed to another bed, between a bed and a cart or gurney, between a sitting and a standing position, or from a slumped position in a chair or bed to a more elevated position.

### BACKGROUND OF THE INVENTION

Health care workers at hospitals, nursing homes, and home care programs face the challenge of moving partly or completely incapacitated patients. A typical patient weighs between 45 and 90 kilograms, although many others weigh more. Consequently, at least two to four health care workers are usually needed to move the patient. These activities often create unacceptable risks of injury, almost without regard to the number of health care workers used in the patient transfer. The risks are particularly high when a sufficient number of workers is not available to assist in a patient transfer. For example, injuries to workers' backs account for approximately 50% of worker's compensation costs for work place injuries in the health care industry in the United States. Thus, back injuries to health care workers are a particularly vexing problem.

Patient transfers can be placed in several broad categories. A first category includes the horizontal transfer of a patient from one flat surface to another. A second category involves upright transfers where a patient is moved from a horizontal position to an upright or sitting position in a wheelchair, chair or commode, and the return of the patient to the horizontal position from an upright or sitting position. A third category of transfer relates to the positioning or movement of patients in order to change their position in a bed or chair, for example pulling the patient up in the bed or rolling the patient from side to side. Although many attempts have been made to devise improved systems for patient transfer, almost all of these transfers continue to be manually performed.

Current healthcare guidelines typically recommend that four health care workers participate in a patient transfer. Two workers are at the bed side and two workers are at the cart side. Each worker grabs an edge of a draw sheet, which is positioned under the patient. The patient is then transferred

between the bed and the cart through a combination of lifting, pulling, and pushing. An elongated plastic sheet is often placed beneath the patient to reduce friction or drag. Since a health care worker has to bend over at the waist to accomplish these patient transfers, the stresses encountered are magnified well beyond what would otherwise be expected for a maximum recommended lift of approximately fifty pounds. Normally this recommended maximum lift is measured with the lift at or near the worker's center of mass. Extremes in a health care worker's height, either taller or shorter than average, or any weakness in either the arms or legs further exaggerate these risks.

Many hospitals have swing-type mechanical lift devices to assist in certain patient transfers. However, these devices are not widely used because they are often cumbersome and time-consuming to set up and operate. Depending on the lift required, the devices may also be inappropriate.

The upright transfer and positioning categories provide similar difficulties, especially if the patient is unable to cooperate. For example, weak and elderly patients reclining in a semi-erect position tend to slide down. These patients must be returned to a position more toward the head of the bed. To do so, two health care workers usually grasp the patient by the upper arms to hoist the patient toward the head of the bed after the bed has been lowered to a more horizontal position. This manual transfer often causes strain on the workers' upper and lower backs and possible contact bruises on the patient. Similar difficulties occur with upright transfers.

Given these formidable difficulties, there have been other attempts to mechanize the patient transfer process. For example, U.S. Pat. No. 2,665,432 (Butler), describes a cart with a manual crank connected to an extensive pull unit. The pull unit has a large number of straps which connect at an edge by hooks to a transfer sheet. Rotation of the crank winds the pull unit onto a roller. The size of the pull unit presents many difficulties including its attachment at many locations to the sheet and the awkwardness of winding it on the roller. The pull unit must be placed under the patient just prior to transfer, since it would not normally be kept there. Also, no means are provided for transferring the patient off the cart.

U.S. Pat. No. 2,827,642 (Huff) describes a similar system mounted to the head of a bed and designed to move a patient from the foot toward the head of the bed. The '642 Patent does not describe the process of moving a patient laterally from one horizontal surface to another.

U.S. Pat. No. 4,970,738 (Cole) discloses another patient transfer system which employs a manual crank and self-locking gear system. This system has an advantage over the system described in the '432 patent in that the transfer is reversible. Rotating the crank drives a belt system, which is attached to a semi-rigid transfer apron. The apron is thereby transferred horizontally while supporting a patient. This system has the disadvantage that the apron must be first positioned under the patient before the patient can be transported from a bed onto a cart. Another disadvantage is that the transfer support alone does not provide sufficient support for the patient or the transfer system. Because of the complexity of its design, considerable operator interaction would be required for the transfer support to be mounted to a cart and then operated to transfer a patient.

U.S. Pat. No. 2,733,452 (Tanney) describes a transfer system that uses a motorized pulley to transfer a patient on a metal-reinforced transfer sheet. The transfer sheet has metal grommets in its corners for attachment to cables. A



motor is used to wind the cables onto reels thereby resulting in the transfer of the sheet and the patient thereon. However, the patient must first be moved onto the transfer sheet before being moved from a bed to the cart. Moreover, this invention fails to provide support beneath a patient being transferred.

U.S. Pat. Nos. 4,747,170 and 4,868,938 (both to Knouse) reveal a motorized winch-type transfer system. This transfer system has apparent advantages over the transfer system of the '452 patent, which include a more secure transfer sheet gripping mechanism and the use of a transfer sheet which does not need grommets or other similar devices. Though more secure, the gripping system is difficult and awkward to use.

U.S. Pat. No. 5,038,424 (Carter et al.) teaches a system for reciprocally transferring a patient between a bed and a cart. This system employs a pliable transfer web wound about two detachable, cylindrical rollers and a drive motor mounted on the bed and the cart. In use, the bed and cart are positioned side-by-side and the web is placed beneath the patient. The roller adjacent the cart or bed onto which the patient is to be transferred is detached. While unwinding a sufficient length of transfer web wound thereon, the roller is extended to the opposite side of the bed or cart onto which the patient is to be transferred, and there connected to the drive motor. The drive motor is then activated, thereby rewinding the transfer web onto the roller and transporting the patient disposed thereon. Thus, while enabling reciprocal transfer, the system of the '424 patent is time consuming and awkward to set up. Moreover, as in the previous inventions discussed hereinabove, the patient is not supported adequately while being transferred.

While considerable effort has gone into developing horizontal patient transfer systems, all of the systems previously developed have significant drawbacks. These drawbacks primarily relate to the significant difficulties encountered in set-up and operation.

The patents described hereinabove primarily relate to systems for transferring patients from one horizontal surface to another horizontal surface. By partial contrast, U.S. Pat. Nos. 4,700,415 and 4,837,873 (both to DiMatteo et al.) teach a system for transferring patients between a reclined wheelchair and a bed. The bed is equipped with a sheet wound about a right side roller and a left side roller. The sheet is positioned beneath a patient reclining thereupon. The right and left side rollers are positioned laterally on each side of the bed, usually slightly below the plane of the patient. Two corner rollers are situated above the right side and left side rollers. The two corner rollers are approximately level with the top surface of the bed. The reclined wheelchair is equipped with two articulated rollers. Extending between these articulated rollers is a sheet, the sheet including three bands. The lateral edges of the sheet may be joined or separate. If the lateral edges are to be joined, the sheet spans above and below the wheelchair upper surface. If the lateral edges are free, the sheet spans the wheelchair upper surface with its ends wound about the two rollers. The separate transfer systems for the bed and wheelchair must be powered such that both sheets rotate with equal velocities. In use, the patient reclining upon the bed is conveyed laterally by the bed transfer system. Upon encountering the wheelchair transfer system, the patient is thereupon further conveyed onto the wheelchair. The wheelchair may then be further adjusted, allowing the patient to assume a sitting position.

The system of DiMatteo allows for transfer to or from a reclining wheelchair and for adjusting the wheelchair between sitting and reclining positions. However, its short-

falls include the complexity of its design, the need to retrofit beds with the rollers and sheet provided, and the possibility of pinching the patient or catching clothing in the gaps between the bands.

U.S. Pat. No. 3,597,774 (Warren) describes a harness and winch mechanism for raising a patient reclining upon a bed. The winch is mounted to a post attached to the head of the bed and is operated by a hand crank. The harness loops under the patient's armpits such that excessive stress may be applied thereto during operation of the device.

#### SUMMARY OF THE INVENTION

The invention includes devices for transferring patients which greatly simplify, and provide enhanced versatility over, any known device. The adoption of these transfer devices will likely reduce the wide incidence of back injuries in health care workers. A first system for the horizontal transfer of patients is adapted to use existing transfer sheets and an appropriately modified cart. The sheet is readily attached to a clamping device close to the patient. The clamping device has a releasable catch which holds the sheet. One or more straps are attached to the clamping device, and the other ends of the straps are attached to reels that are part of a winch. Activation of the winch winds the straps onto the reels. In a highly portable embodiment of this transfer device, the entire apparatus may weight only about 8-15 kilograms, and may be readily attachable and removable to bed and cart rails.

A long narrow rectangular cushion can be placed between the bed and cart when using the portable transfer device. The cushion is, optionally, the length of the bed, and may be partially coated with a low friction surface. The cushion may have fasteners for attachment to a bed or cart, or it may also be configured to hang from the side of the bed or cart by the fasteners when not in use. The cushion is particularly convenient when used with a portable transfer device of the invention because no other modifications to the bed or cart may be needed.

Other embodiments of horizontal transfer devices facilitate the transfer of the patient by providing some lift to the patient as well as horizontal motion. The vertical and horizontal transfer mechanisms may both be operably attached to a single bed or cart frame. One embodiment of a horizontal transfer mechanism within the invention has a transfer element that moves within tracks. Another embodiment of a horizontal transfer system of the invention moves the patient on a modularized cushion. In other embodiments, lift is added by use of a harness which provides significant advantage in distributing the weight of the patient without the need to lift the patient to place a portion of the harness under the patient. The harness has a support that goes across the patient's upper body. Another portion of the harness goes under the patient's arms. The harness has a fastener that attaches a lift mechanism near the back of the patient's head.

An improved patient transfer system is capable of transferring a patient using only a single attendant. The transfer system includes patient transfer means for transferring the patient, a transfer sheet, a retaining member assembly operably coupled to the patient transfer means and a contact element assembly.

The improved transfer system may also include a highly portable transfer unit. The portable transfer unit may be totally self-contained or may be installable on a bed or cart and connectable to a separate clamp. The portable transfer unit may utilize a plurality of detachable spools, as well as means for sensing the proximity of a patient being transferred and means for discontinuing the transfer in response to the sensing.



The improved transfer system may still further include a transfer bridge support means for supporting a patient being transported when the patient spans the bed or cart. The transfer bridge support means may be foldable and may include a stabilizer, a cross sectional camber and a leading edge camber to further prevent the transfer bridge support means from being displaced during patient transfer, and improved slip-resistant features.

A system for enabling a person to singly and ergonomically transfer a patient disposed on a sheet as provided. The system may include a caddy. The caddy may include means for enabling the person to transport the caddy from a first location to a second location, a power train, a hook and web assembly attachable to the power train, a power and switching system in electrical communication with the power train, and means for adjusting a vertical position of the hook and web assembly. The transport means may be operably disposed proximate the caddy. The system may further include means for gradually accelerating and decelerating a transfer force exerted by the power train. The power train may include a motor and a plurality of spools in mechanical communication with the motor. The plurality of spools may further be in mechanical and magnetic communication with the motor. The power train may still further include a plurality of magnetic clutch assemblies and a plurality of slip plates. Each magnetic clutch assembly may be in mechanical communication with the motor and each slip plate may be in magnetic communication with one of the magnetic clutch assemblies. Each spool may be in mechanical communication with one of the slip plates.

The hook and web assembly may include a plurality of webs and a plurality of transfer hooks, each web being connectable to one of the spools and each transfer hook being connectable to one of the webs. The power and switching system may further include means for automatically discontinuing a transfer. The system may provide a transfer rod, the transfer rod accommodating the transfer hook when at least a portion of the transfer sheet is wrapped around the transfer hook. The transfer rod may include a plurality of joinable sections, the sections may be elastically connected.

The system may further include a transfer bridge. The transfer bridge may further include a low-friction surface and a plurality of sections, foldable into a generally facing relationship.

There is also provided a movable caddy for enabling a single person to ergonomically turn a patient disposed on a sheet in cooperation with sheet-gripping means or to transfer the patient from a first horizontal surface to a second horizontal surface in cooperation with the sheet-gripping means. The caddy may include a base assembly, the base assembly including means enabling a single person to transport the caddy from a first site to a second site, a vertical adjustable head assembly, the vertical adjustable head assembly including a power train, the power train including a motor, a plurality of magnetic clutches, a plurality of slip plates, and a plurality of spools. Each magnetic clutch may be in mechanical communication with the motor. Each slip plate may be in magnetic communication with one of the magnetic clutches. Each spool may be in mechanical communication with one of the slip plates. The magnetic clutches and the slip plates may cooperate to exert a gradually accelerable transfer force. The system may further include a hook and web assembly with a plurality of webs and means for gripping the sheet. A first end of each web may be windably attachable to one of the spools. The sheet-gripping means may be attachable to a second end of

each of the belts. The sheet-gripping means may grip a portion of the sheet, thereby transmitting the transfer force to the gripped sheet. The sheet-gripping means may include a plurality of transfer hooks and a transfer rod. Each transfer hook may be attachable to a second end of each belt and each transfer hook may cooperate with a transfer rod to grip the sheet.

There is also provided a transfer rod for cooperatively gripping and exerting a transfer force on a sheet. A portion of the sheet may be partially enwrapped around the transfer rod, the transfer rod exerting the transfer force in cooperation with the plurality of transfer hooks. The transfer rod may include means for mating with the transfer hooks.

There is also provided a transfer bridge. The transfer bridge may include a first inboard member, a plurality of outboard members, means for interfolding the inboard and outboard members, and means for reducing friction arising from contact between a sheet and the transfer bridge. An outboard member may extend from a lateral edge of the first inboard member. The transfer bridge may include a second inboard member and an outboard member may extend from each inboard member.

There is provided a substantially pliable underlayment for transferring, repositioning, or rolling a patient disposed thereon, the underlayment including a substantially smooth mantle proportioned to accommodate at least a central portion of the patient's body, an attaching structure operably adjacent the mantle, and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure.

There is also provided a method of transferring or repositioning a patient disposed on a substantially pliable underlayment, the method comprising the steps of providing the substantially pliable underlayment, the underlayment including a substantially smooth and pliable mantle, an attaching structure operably adjacent the mantle, and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure; attaching a connecting member to the attaching structure; and exerting the force on the connecting member, the force being sufficient to displace the patient.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a bed with an adjacent cart adapted with a first embodiment of a horizontal patient transfer system;

FIG. 2 is a front, schematic view of a cart adapted with the first embodiment of a horizontal patient transfer system with side rails in a lowered storage position;

FIG. 3 is a front, schematic view of a cart adapted with the first embodiment of a horizontal patient transfer system with side rails in a raised patient transport position;

FIG. 4 is a front, schematic view of a cart adapted with the first embodiment of a horizontal patient transfer system with one side rail in a raised position and a second side rail in a bridge position used during patient transfer;

FIG. 5 is a front fragmentary view of one embodiment of hinges supporting a side rail;

FIG. 6 is an exploded view of a side rail of the first embodiment of a horizontal transfer system;

FIG. 7 is a cut away view of a second drive system within the side rail;

FIG. 8 is a perspective view of a first embodiment of a clamping device useful with a first embodiment of the horizontal transfer system in an orientation to be clamped to a transfer sheet folded over a rod;



FIG. 9 is an end view of a first embodiment of the clamping device;

FIG. 10 is a perspective view of a second embodiment of the clamping device;

FIG. 11 is an end view of the second embodiment of the clamping device;

FIG. 12 is a perspective view of a third embodiment of the clamping device;

FIG. 13 is an end view of the third embodiment of the clamping device;

FIG. 14 is a perspective view of the attachment of a portable horizontal transfer device for the transfer of a patient from one horizontal surface to another;

FIG. 15 is a perspective view of the portable horizontal transfer device;

FIG. 16 is an exploded view of the portable horizontal transfer device;

FIG. 17 is a perspective view of a portable cushion attached to a horizontal surface to provide a smooth continuous surface for the transfer of a patient with the portable horizontal transfer system, with the cushion in a lowered, stored position shown in phantom lines;

FIG. 18 is a perspective view of a further embodiment of a horizontal transfer system;

FIG. 19 is a partial, cut away perspective view of the further embodiment of the horizontal transfer system showing the drive system for horizontal extensions;

FIG. 20 is a perspective view of the further embodiment of the horizontal transfer system with a patient elevated over a cart to indicate the ranges of motion obtainable by the transfer system;

FIG. 21 is a perspective view of the further embodiment of the horizontal transfer system with an alternative design for the horizontal drive;

FIG. 22 is a fragmentary perspective view of a sheet clamp indicating its motion relative to a lifting support and its attachment to a transfer sheet;

FIG. 23 is a perspective view of a bed equipped with the further embodiment of the horizontal transfer device with the bed in a raised position;

FIG. 24 is a partial perspective view of one end of the embodiment of FIG. 21 with an arrow showing the disengagement of a removable panel;

FIG. 25 is a partial perspective view of one end of the embodiment of FIG. 21 with a removable panel attached as a shelf;

FIG. 26 is a perspective view of a portion of the foot board bed or cart adapted with the further embodiment of the horizontal transfer system indicating a location for the attachment of a control unit;

FIG. 27 is a top view of a transfer sheet designed for use with the further embodiment of the horizontal transfer system;

FIG. 28 is a perspective view of the transfer sheet of FIG. 27 shown in its folded position;

FIG. 29 is perspective view of an alternative embodiment of the horizontal transfer system;

FIG. 30 is a perspective view of a portion of the alternative embodiment of FIG. 29 showing extendable horizontal supports;

FIG. 31 is a perspective view of the alternative embodiment of FIG. 29 being used to assist a patient to sit up;

FIG. 32 is a perspective view as in FIG. 31 indicating the rotation of a lifting element;

FIG. 33 is a perspective view of a transfer system with a horizontal transfer mechanism;

FIG. 34 is a cut away side view of one embodiment of a docking mechanism;

FIG. 35 is a cut away side view of a second embodiment of a docking mechanism;

FIG. 36 is a perspective view of the transfer system of FIG. 33 with a transfer element bridging between a bed and a cart;

FIG. 37 is a perspective view of a transfer bridge used with the transfer system of FIG. 33;

FIG. 38 is a perspective view of the transfer bridge of FIG. 37 with the bridge in the bridging position;

FIG. 39 is a side view of the transfer bridge in the bridging position with lever and rods removed;

FIG. 40 is a side view of the transfer bridge in the raised position with lever and rods removed;

FIG. 41 is a perspective view of a split transfer bridge;

FIG. 42 is a perspective view of a mattress transfer system;

FIG. 43 is a perspective view of a docking mechanism used with the mattress transfer system of FIG. 42;

FIG. 44 is a perspective view of a gripping mechanism of the mattress transfer system in pushing position;

FIG. 45 is a perspective view of a gripping mechanism of the mattress transfer system in pulling position;

FIG. 46 is an exposed, top perspective view of a mattress and fixed cushion of the mattress transfer system indicating the location of structures within and below the mattress and cushion;

FIG. 47 is a perspective view of a mattress transfer system used with a position changing cart and a folding mattress;

FIG. 48 is a perspective view of the mattress transfer system and position changing cart depicting the cart in a folded position;

FIG. 49 is a side view of the position changing cart in the chair orientation;

FIG. 50 is a perspective view of a lobster claw type of bed jacket being placed on one side of a person;

FIG. 51 is a perspective view of the bed jacket in place around a person;

FIG. 52 is a perspective view of the bed jacket secured around a person and hooked to a hoisting mechanism;

FIG. 53 is a perspective view of a motorized bed jacket attached to a stand above a wheel chair;

FIG. 54 is a front view of a padded vest;

FIG. 55 is a perspective view of the padded vest around a person and attached to a tether where hidden portions of the vest are depicted with phantom line;

FIG. 56 is a perspective view of a motorized bed jacket being attached to a mount above a headboard;

FIG. 57 is a top perspective view of the motorized bed jacket;

FIG. 58 is a partial cut away view of the drive system of the motorized bed jacket;

FIG. 59 is a perspective view of a bed jacket attached to three hoisting mechanism on a ceiling using a three way control cylinder;

FIG. 60 is a side perspective view of the three way control cylinder;

FIG. 61 is a schematic view of the internal components of the three way control unit;



FIG. 62 is a top right perspective view of another clamp embodiment of the present invention;

FIG. 63 is a side plan view of the clamp of FIG. 62, in an open position;

FIG. 64 is a side plan view of the clamp of FIG. 62 in a closed, locked position;

FIG. 65 is a top perspective view of another clamp embodiment of the present invention, the clamp disassembled and depicted in an exploded view;

FIG. 66 is a top perspective view of the clamp of FIG. 65 assembled;

FIG. 67 is a top plan view of another clamp of the present invention;

FIG. 68 is a side plan view of the clamp embodiment of FIG. 67;

FIG. 69 is another embodiment of the transfer system of the present invention, whereby a patient may be bidirectionally transferred without the necessity of reinstalling this embodiment on another bed or cart;

FIG. 70 is a side plan view of the embodiment of FIG. 69, wherein a patient is being transferred away from the bed on which the embodiment is installed;

FIG. 71 is a side plan view of the embodiment of FIG. 69, wherein a patient is being transferred onto the bed or cart onto which the embodiment is installed;

FIG. 72 is a top, side perspective view of a remote control usable for any of the embodiments described herein;

FIG. 73 is a top, side view of a remote control, which may be used for any of the embodiments described herein;

FIG. 74 is a top, side perspective view of a portable transfer device and clamp installed onto a hospital bed;

FIG. 75 is a top, side perspective view of an embodiment of the portable transfer device, wherein a spool or reel may be detachably installed onto a drive shaft;

FIG. 76 is a side plan view of any of the portable transfer devices of the present invention depicting a reel for winding a retraction belt, wherein an automatic cutoff device is operationally installed;

FIG. 77 is another embodiment of a portable transfer device installed onto a bed, and wherein one of the clamps of the present invention is connected thereto by means of belts;

FIG. 78 is a side view of any of the portable transfer devices of the present invention, depicting a mounting bracket and quick release pin;

FIG. 79 is a top perspective view of another portable transfer device of the present invention;

FIG. 80 is a top perspective view of a detachable remote control for any of the portable transfer devices of the present invention;

FIG. 81 is a fragmentary top perspective view of a portable transfer device of the present invention, depicting a clip for securing the jaws therein;

FIG. 82 is a fragmentary top perspective view of a portable transfer device of the present invention, depicting a lock-down device for securing the jaws thereto;

FIG. 83 is a top plan view of a portable transfer device of the present invention, depicting the downwardly opening jaw portion of the clamp thereto;

FIG. 84 is a side plan view of a portable transfer device of the present invention, depicting an upwardly opening jaw portion thereof;

FIG. 85 is a top plan view of a motor and winch system, suitable for any of the transfer devices of the present invention;

FIG. 86 is an exploded view of the motor and winch assembly of FIG. 85;

FIG. 87 is a top front perspective view of a transfer bridge spanning a gap between a bed with a patient reclining thereon and a transfer cart;

FIG. 88 is a bottom plan view of an alternate embodiment of the transfer bridge of FIG. 87;

FIG. 89 is a fragmentary side view of the transfer bridge of FIG. 87 or FIG. 88, depicting the hinge thereon;

FIG. 90 is a top front perspective of the bridge of FIG. 87 being folded and prepared for either transport or storage;

FIG. 91 is an exploded view of a clamp of the present invention;

FIG. 92 is a top perspective view of the assembled clamp of FIG. 91;

FIG. 93 is a side perspective view of a portable transfer unit;

FIG. 94 is a side plan view of the portable transfer unit of FIG. 93;

FIG. 95 depicts an attendant carrying a portable transfer unit;

FIG. 96 is an elevated left perspective view of the patient transfer system of the present invention;

FIG. 97 is an elevated left perspective view thereof;

FIG. 98 is an exploded view of the top frame of the present invention;

FIG. 99 is an exploded view of the base assembly thereof;

FIG. 100 is a left elevated perspective view of the remote switch of the patient transfer system of FIG. 96;

FIG. 101 is an exploded view depicting the components of the switch of FIG. 100;

FIG. 102 is an elevated perspective view of a transfer rod of the present invention;

FIG. 103 is an exploded view of the transfer rod of FIG. 102;

FIG. 104 is a fragmentary elevated perspective view depicting how the elastic cord is secured to the cord plate of the transfer rod of FIG. 102;

FIG. 105 is a top plan view of the transport rod of FIG. 102 being disassembled for storage or transport;

FIG. 106 is a top plan view of the transfer rod of FIG. 105 partially disassembled;

FIG. 107 is a side plan view of the transfer rod of FIG. 102 disassembled and ready for storage;

FIG. 108 is an elevated perspective view of the transfer bridge of the present invention;

FIG. 109 is a cross section taken along lines 109—109 of FIG. 108;

FIG. 110 is a side plan view depicting the transfer bridge of FIG. 108 being folded for storage or transport;

FIG. 111 is a side plan view of the transfer bridge of FIG. 108 being completely folded and ready for storage or transport;

FIG. 112 is a side plan view of the patient transfer system of FIG. 96 depicting the transfer rod and the transfer bridge in storage positions;

FIG. 113 is a side plan view of the patient transfer system of FIG. 96 depicting vertical adjustment of the head assembly;

FIG. 114 is a fragmentary elevated perspective view of the head assembly of the lateral patient transfer system with the upper shield removed;



FIG. 115 is a fragmentary side view of the head assembly of the lateral patient transfer system depicting a patient transfer in progress;

FIG. 116 is a fragmentary side plan view of the patient transfer system depicting completion of a patient transfer event;

FIG. 117 is a fragmentary elevated perspective view of the webbing attached to the drum of the head assembly and extending through a slot therefor in the top frame and upper shield and further depicting an interlock switch in place thereto;

FIG. 118 is a top plan view of a webbing attached to the drum of the transfer system of FIG. 96;

FIG. 119 is a fragmentary elevated perspective view of the transfer hook, joint connector, and webbing of the present invention;

FIG. 120 is a side plan view of the hook, joint connector, and webbing of FIG. 119;

FIG. 121 is a fragmentary elevated right perspective view of the base assembly of the present invention depicting attachment of the cable to the peddle and actuator assembly thereof;

FIGS. 122–132 sequentially depict a patient transfer event by an attendant using the patient transfer system of the present invention;

FIG. 133 is a fragmentary elevated left perspective view of a transfer hook emplaced over an enwrapped transfer bar of the present invention;

FIG. 134 is a diagram of the electrical and switching system of the present invention;

FIG. 135 is an elevated perspective view of another embodiment of the patient transfer system of FIG. 96, with extended bumpers;

FIG. 136 is a top plan view of a pair of sheet grippers alternately used with the patient transfer system of FIGS. 96 and 135;

FIG. 137 is an elevated left perspective view of an alternate embodiment of the patient transfer system of FIG. 96;

FIG. 138 is an elevated rear perspective view of another alternate embodiment of the patient transfer system of FIG. 96;

FIG. 139 is a fragmentary perspective view of a stabilizing weight being positioned on a bumper of the transfer caddy of FIG. 96;

FIG. 140 is a fragmentary elevated perspective view of the transfer caddy of FIG. 139 with the weight in place;

FIG. 141 is a side view of the transfer caddy of FIG. 140;

FIG. 142 is a bottom plan view of another embodiment of a stabilizing weigh to be installed on the transfer caddy of FIG. 96;

FIG. 143 is a front exploded view depicting placement of the weight of FIG. 142;

FIG. 144 is a side view depicting the weight of FIG. 142 installed on the transfer caddy of FIG. 96;

FIG. 145 is a top plan view of a first embodiment of a transfer sheet cooperating with a plurality of attaching members to form pockets;

FIG. 146 is a top plan view of a second embodiment of the sheet of FIG. 145;

FIG. 147 is a top plan view of a third embodiment of the sheet of FIG. 145;

FIG. 148 is a fragmentary perspective view of the sheet of FIG. 145 with a repositioning bar being inserted therein;

FIG. 149 is a fragmentary perspective view of the sheet of FIG. 145 with a repositioning bar in place;

FIG. 150 is fragmentary perspective view of the sheet of FIG. 145 with a repositioning bar inserted and with a transfer hook being attached thereto;

FIG. 151 is a fragmentary perspective view of a first embodiment of another sheet of this invention;

FIG. 152 is a fragmentary perspective view of a second embodiment of the sheet of FIG. 151;

FIG. 153 is a fragmentary perspective view of a third embodiment of the sheet of FIG. 151;

FIG. 154 is a fragmentary perspective view of a fourth embodiment of the sheet of FIG. 151;

FIG. 155 is a fragmentary perspective view of a transfer hook being connected to the sheet of FIG. 154;

FIG. 156 is a top plan view of a transfer and repositioning sheet of this invention;

FIG. 157 is a sectional view of the sheet of FIG. 156 taken along line 157—157;

FIG. 158 is a top plan view of a drawsheet layer of the sheet of FIG. 156;

FIG. 159 is a sectional view of an alternate embodiment of the sheet of FIG. 156;

FIG. 160 is a fragmentary perspective view of another embodiment of a transfer and repositioning sheet of this invention;

FIG. 161 is a top plan view of the sheet of FIG. 160;

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention includes improved devices and methods for moving and repositioning patients and other individuals who lack full mobility. Patients must be moved in a variety of ways in health care facilities such as hospitals, nursing homes and other residences. For example, patients may need to be transferred horizontally between a bed and a cart, they may need to be repositioned in a bed or chair, or they may need to assume a prone, sitting or standing position. The unifying feature of the various embodiments of this invention is enabling empowering a single health care worker to move a patient in a substantially low risk manner to either the patient or the healthcare worker. The embodiments of this invention further allow a patient transfer event to require between about 20 seconds and 28 seconds and preferably about 24 seconds.

A feature of the horizontal transfer systems of the present invention includes a support beneath the patient and a mechanical or electromechanical system for applying a horizontal force to the support to effect the transfer. The designs of the various embodiments incorporate varying features to achieve this utility. In order to reduce cost, the simplest systems are designed to be adapted for use with beds, carts and transfer sheets now commonly in use in health care facilities. Other embodiments optimize the particular characteristics of the design with less regard to adaptation to existing equipment. In all cases, each design focuses toward the goal of a safe and efficient ergonomic patient transfer event by a single health care worker. Each design also focuses toward greatly reducing the number of healthcare workers required for each transfer event.

This is a continuation-in-part of U.S. patent application Ser. No. 08/713,412, filed Sep. 13, 1996, which is a continuation-in-part of U.S. patent application Ser. No. 08/527,519, now U.S. Pat. No. 5,737,781. The embodiments



of the present invention described hereinbelow are also disclosed in U.S. Provisional Application Ser. No. 60/023, 572, filed Aug. 19, 1996, in U.S. Provisional Application Ser. No. 60/025,084, filed Aug. 30, 1996, and U.S. Provisional Application No. 60/043,208, filed Apr. 8, 1997, the entire contents of each being hereby incorporated by reference.

Referring to FIG. 1, the first exemplary embodiment of horizontal transfer system **100** includes standard patient cart **102** retrofitted with horizontal transfer mechanism **104**. Cart **102** will generally have base **106** with four wheels **108**. Wheels **108** preferably have lock levers **110** for applying brakes to prevent rotation of wheels **108**. Base **106** may have a top surface **112** that usually, but not necessarily, will have a flat portion **114**.

Cart **102** includes support portion **116**. Support portion **116** is attached to base **106** by one or more upright supports **118**. The exemplary embodiment represented in FIG. 1 has two upright supports **118**. Some designs may have wheels **108** attached directly to upright supports **118**, thereby eliminating the need for base **106**. Support portion **116** will preferably include cushioned bumpers **120**. Cart **102** may have the capability of raising and lowering support portion **116** relative to base **106**, as well as other features. Support portion **116** provides support structure **122** for supporting cushion (or mattress) **124** for holding patient **126**.

Exemplary horizontal transfer mechanism **104** includes two side rails **128**. Referring to FIG. 5, side rails **128** are mounted to cart **102** by hinges **130**, **131**. Side rails **128** and hinges **130**, **131** are preferably adapted from existing side rails and hinges on cart **102**. Hinges **130**, **131** can adjust to place side rails **128** in either an elevated pull position or a lowered storage position as depicted in FIG. 2. Preferably, hinges **130**, **131** are used to place side rails **128** in a horizontal bridge position to provide support and a smooth surface for transferring the patient (FIG. 4). The different positions are schematically depicted in FIGS. 2-4. Alternative designs for the side rail may allow for the side rail to slide straight down to a lowered position, although other variations are within the spirit and scope of this invention.

Referring to FIG. 6, each exemplary side rail **128** includes handle **132**, control panel **134** and a plurality of openings **136** for a power assembly, such as winch **138**. Other openings may be used for access to the winch unit. Control panel **134** has a plurality of switches **140** to control the operation of winch **138**. The particular design of side rail **128** and control panel **134** may be varied without effecting their function.

Referring to FIG. 6, a convenient structure for side rail **128** includes frame **142**, winch **138**, front cover **144** and back cover **146**. Frame **142** further includes extensions **148** attached to frame substructure **150** at frame hinge **152**. Frame substructure **150** may include winch mounting portion **154**. Frame substructure **150** may be made from metal, a rigid polymer or a composite material, although other materials exhibiting the proper strength, weight, and cost characteristics may be suitable. Back cover **146** may define open portions **156** and handle **132**. In this example, extensions **148** are disposed through open portion **156**. Moreover, the sizes and configurations of open portions **156** admit frame hinges **152**. Open portions **152** are further dimensioned to admit coincident movement when side rail **128** is raised or lowered by pivoting side rail **128** on hinges **152**. Outer surface **147** of back cover **146** (FIG. 5) is a transfer surface which may include a low friction material to assist with the transfer process and reduce the risk of injury. Front

cover **144** includes a mated part of handle **132**. Front cover **144** further defines openings **136** and control panel opening **158**.

Winch **138** is coupled to control panel **134** by wires **160**. A conventional manual winch may also be used without excess difficulty, but less conveniently. Drive system **143** may include at least one motor **162**. Both drive system **143** and motor **162** may be configured in a variety of conventional designs. Motor **162** may directly rotate drive shaft **164** as depicted in FIG. 6. In the embodiment of FIG. 7, motor **162** rotates first drive shaft **165**, thereby rotating first gear **166**. First gear **166** engages second gear **168**. Second gear **168** is connected to second drive shaft **170**. Second gear **168** may have a larger diameter than first gear **166**, thereby causing a reduced rate of rotation of second drive shaft **170** relative to first draft shaft **165**.

Two belts **172** each with a clip **174** are attached to second drive shaft **170** at positions coincident openings **136**. Belts **172** preferably wind on spools **175**. Spools **175** help ensure that belts **172** wind and unwind straight. Belts **172** are preferably made from very strong synthetic fabric such as the material used in seat belts for automobiles. Winch **138** may be powered by a battery pack **176**. Winch **138** and battery pack **176** are electrically connected by power cord **178**. Alternatively, winch **138** may be powered by alternating current using another power cord (not shown). Cart **102**, or any other embodiment of the present invention, may also include aligning and docking mechanisms. Aligning mechanisms may further include powering and steering means, whereby at least two wheels **108** of cart **102** are powered and steered by operation of control switches **140**. Docking mechanisms may include clamps and electromagnets. These clamps and electromagnets may also be operated by control switches **140**. These clamps and electromagnets may secure cart **102** to the horizontal surface onto which the patient is to be transferred.

In addition to control switches **140**, hand-held remote control units communicating with the control mechanism of cart **102** by electric or electromagnetic means are within the scope of the present invention. Voice actuated controls are also within the scope of the present invention, thereby enabling the patient, as well as an attendant, to begin and discontinue a transfer event.

Cart **102**, or any other embodiment of the present invention, may further include means for sensing an asynchronous operation of the transfer mechanisms. Such means include sensing the individual belt torque or drag experienced when belts **172** are being retracted and a comparison of these sensings. A difference between sensings exceeding a predetermined value or a sensing ratio greater than or less than a predetermined ratio range would result in an alarm being actuated or an automatic discontinuance of transfer.

Cart **102** of FIG. 1 is designed for use with standard patient draw sheet **190**. Standard patient draw sheet **190** is sufficiently wide that it can be folded over patient **126** if desired. Typically draw sheet **190** is not long enough that it extends under the head or feet of the patient. Rather than using several persons to move the patient disposed on draw sheet **190**, horizontal transfer mechanism **104** performs a comparable function. Clips **174** are designed to attach directly to draw sheet **190**. However, a worker may also use another clamping device to provide a more even pull over more of the length of sheet **190** and thus provide a smoother transfer motion to the patient. For particularly tall patients, draw sheet **190** may be wrapped around patient **126** for added support. Both ends of draw sheet **190** are then attached to the clamping device.



Three embodiments of exemplary clamping device **194** are presented in FIGS. **8–13**. The first embodiment of clamping device **194** is shown in FIGS. **8** and **9**. Clamping device **194** may be used to attach draw sheet **190** to winch **138**. Clamping device **194** may employ rod **192** in doing so. A cross section of clamp **196** includes U-shaped portion **196**, which forms cavity **198**. Cavity **198**, in turn, is covered by spring loaded gate **200**. Rod **192** can enter cavity **198** when pushed against gate **200**. Force from rod **192** against gate **200** from inside cavity **198** tends to force gate **200** closed, thereby further preventing withdrawal of rod **192**. Gate **200** includes upward extension **202**. Forward force on upward extension **202** opens gate **200** for the withdrawal of rod **192** from cavity **198**. Clips **174** are conveniently attached to clamping device **194** at J-shaped flanges **204**. Rod **192** can be optionally tethered to the clamping device **194** at one or more positions. Rod **192** may also be clipped to clamping device **194** for storage.

In the second and third embodiments, clamping device **194** includes upper portion **206** and lower portion **208** attached at hinge **210**, thereby defining cavity **212**. The front of cavity **212** is closed by L-shaped, hinged closure **214**. The two embodiments to device **194** differ in their design for J-shaped flanges **216**, **218** for attaching clips **174**. In these embodiments, sheet **190** is directly placed into cavity **212** without the need to wrap sheet **190** around rod **192**. However, rod **192** could still be used if desired. Sheet **190** is held in place by L-shaped hinge closure **214**. A thin rigid tucking device (not shown) of any convenient length may be used if desired to assist with tucking sheet **190** into clamp **194**.

Clearly, a variety of other designs for clamping device **194** are possible within the general concepts presented. In each of these embodiments, any portion of sheet **190** may be attached, not just the edge of sheet **190**. This is an important feature because clamping device **194** should preferably be placed as near as possible to the patient so that transfer mechanism **104** can fully transfer the patient from the first horizontal surface to the second.

In operation, cart **102** is wheeled to a patient's bed **220**, as depicted in FIG. **1**, or onto another cart. Side rail **128** facing bed **220** is placed in the bridge position with low friction surface **147** directed upward. Draw sheet **190** is attached to a clamping device. Belts **172** are unwound from drive shafts **164** or **170** until they reach rod **192** at the edge of bed **220**. Belts **172** are unwound either by activating motor **162** to unwind them or by using a clutch (not shown) to allow belts **172** to be freely withdrawn from the drive shaft. Clips **174** on the ends of belts **172** are attached to exemplary clamping device **194**. Clamping device **194** is then engaged by rod **192** and sheet **190**. Other embodiments of clamping device **194** may be used with or without rod **192**.

After the appropriate switch mechanism **140** is actuated, winch **138** begins winding belts **172** onto drive shafts **164** (FIG. **6**) or spool **175** (FIG. **7**). Motor **162** may be designed to apply a slow, steady and constant force to move patient **126** without jerking. Motor **162** may further advantageously provide variable speeds of movement consistent with gradual starts and stops and safe transfer throughout the length of travel. Draw sheet **190** helps to distribute transfer forces over significant areas of the patient's body. When patient **126** is on cart cushion **124**, motor **162** is turned off or otherwise disengaged. At this point, belts **172** are disconnected from clamping device **194**. Sheet **190** is then removed from clamping device **194**.

To transfer a patient from a cart to a bed, the bed should be equipped with a winch such as winch **138** present on cart

**102**. This bed-based transfer device may include the side rails of a conventional bed. These side rails typically slide vertically rather than folding under the bed. Winch **138** could easily be adapted on one or both sides of the bed, and may be retrofitted to a bed in a comparable fashion as with cart **102**, based on the above description.

Alternatively, a portable winch unit readily carried by a single health care provider may be used to replace winch **138** on bed **220**, or cart **102**. Exemplary portable winch unit **250** is shown in FIGS. **14–16**. Portable winch unit **250** includes housing **252**, clamping device **254** and winch **256**. Clamping device **254** may hold and grip transfer sheet **190** in a similar manner as clamping device **194**. Clamping device **254** also serves as a frame or a portion of a frame for the portable winch unit **250**. Housing **252** preferably includes top portion **258** and bottom portion **260**. Top portion **258** and bottom portion **260** may be heavy plastic shells surrounding clamping device **254** and winch **256**.

Winch **256** includes motor **262**. In operation motor **262** rotates a drive shaft (not shown) on which reel **263** is mounted. Belt **264** winds around reel **263**. Belt **264** is comparable to belts **172** in embodiment **100**. Handle **266** attaches to a free end of belt **264**. Handle **266**, in turn, attaches to clamp **268**. Clamp **268** attaches to the edge of a bed or cart. Clamp **268** may be designed to fold out of the way when not in use. Belt **264** passes out of housing **252** through opening **270**. The operation of winch **256** may be controlled through circuit board **272**. Circuit board **272** may electrically connect to motor **262** by means of wire **274**. Circuit board **272** may be electrically connected to port **276**.

Control unit **278** with switches **280** may be electrically connected to port **276** by way of tether **282**. The operator may operate winch **256** using control unit **278**. Alternatively, control switches **280** may be present within housing **252**, as shown in FIG. **15**. However, this may be less desirable because the operator would need to lean over the bed or cart while the patient was being transferred. Control unit **278** may also have a wireless connection with circuit board **272** using a transmitter/receiver (not shown). Winch **256** may be powered by a standard wall outlet using cord **284**. Retractable cord assembly **286** may be used to retract cord **284** when cord **284** is not in use. Retractable cord assembly **286** may also be used to prevent excess cord from being in the way during a patient transfer. Alternatively, a battery, preferably rechargeable, may be used to power winch **256**.

As shown in FIG. **14**, a patient may be transferred from a first bed/cart **288** to a second bed/cart **290**. Draw sheet **190** may be disposed under the patient in a similar manner as described above with respect to embodiment **100**. FIG. **17** depicts portable cushion **292**. Cushion **292** may be placed between the first bed/cart **288** and the second bed/cart **290** to provide a relatively smooth continuous surface for transferring the patient. Mating portions of a hook and loop fastener are present on a surface of portable cushion **292** and the bed or cart. Thus, portable cushion **292** may be attached to the bed or cart when not in use. Portable cushion **292** may also be used with other transfer devices or as an aid during a manual transfer. A top surface of cushion **292** may include a very low friction material. The very low friction material may be plastic.

Portable winch unit **250** may be attached to draw sheet **190** by means of clamping device **254**, (FIGS. **15**, **16**). The design of clamping device **254** may be similar to the clamping devices in FIGS. **8–13** or a comparable design based on similar concepts. Draw sheet **190** may be wrapped about rod **192** (FIG. **8**) for attachment to clamping device



254. Referring to FIG. 14, belt 264 is withdrawn from housing 252 so that handle 266 can be attached to clamp 268. Clamp 268 is rigidly attached to second bed/cart 290 on its side opposite the side near first bed/cart 288. Clamp 268 can be optionally reversibly detachable or lowerable to a storage position. The operator uses control unit 278 to activate motor 262. As motor 262 retracts belt 264, portable winch unit 250 and the patient are drawn toward clamp 268 which result in the patient being moved onto second bed/cart 290.

Referring to FIG. 14, the transfer devices of the present invention, especially the clamps, are designed to be centered at the patient's center of gravity when the patient is in a supine position. A patient's center of gravity is usually about midway between the patient's navel and buttocks, represented as lines N and B, respectively. Thus, to move the patient smoothly and evenly, the clamp center of gravity (represented by arrow C) should be aligned about midway between lines N and B on the patient.

Exemplary horizontal transfer system 300 includes an especially designed transfer sheet 302 and transfer unit 304, as shown in FIG. 18. Transfer unit 304 can move a patient in either of two directions. Thus, horizontal transfer system 300 has the advantage that only the cart or bed, but not both, must be equipped with transfer unit 304. Therefore, the cart or bed not adapted by transfer unit 304 may be conventional in design.

Transfer unit 304 includes head frame 306 and foot frame 308. Head frame 306 and foot frame 308 are in mechanical communication with drive system 310 (FIG. 19). Head frame 306 replaces or attaches to the head board of the bed or cart. Foot frame 308 replaces or is attached to the foot board of the bed or cart. Head frame 306 and foot frame 308 include at least one vertical support 312. A bottom portion of vertical support 312 may include wheel 314. Wheels 314 are oriented to roll in a direction defined by the width of the bed/cart. Wheels 314 may be attached to vertical support 312 in such a manner that wheels 314 are shifted up and out of contact with the floor. Thus, the bed or cart may then be moved more easily because wheels 314 are retracted away from the floor. Vertical supports 312 may have a removable brace (not shown) extending therebetween. When in use, the removable braces serve to enable vertical supports 312 to become more rigid by compensating for forces created by the weight of the patient during transport.

Referring to FIGS. 19–21, head frame 306 and foot frame 308 each include at least one expandable horizontal support 316 and lifting support 324. Each horizontal support 316 extends from vertical supports 312. Horizontal supports 316 include fixed portions 318 and telescoping portions 322. Fixed portions 318 are attached to the head board, foot board, head board portion 320, or foot board portion 320. Fixed portions 318 may extend at least across the width of the bed or cart. Telescoping portions 322 are attached to each vertical support 312 and slidably engage a corresponding fixed portion 318. In certain embodiments, telescoping portion 322 will slide into a corresponding fixed portion 318, although other types of slidable engagement are possible.

Lifting support 324 slidably attaches to fixed portion 318 such that lifting support 324 moves with vertical support 312 and telescoping portions 322. Each lifting support 324 includes gripping portion 328 and two lifting portions 330. Gripping portion 328 may define opening 332. Sheet clamp 325 will be discussed in more detail hereinbelow. However, first ends of cables 327 may extend from sheet clamp 325 through opening 332. Second ends of cables 327 may be

secured to gripping portion 328. Thus, raising lifting support 324 will also raise clamp 325. Referring to FIG. 23, cables 327 permit sheet clamps 325 to remain attached to transfer sheet 302 while mattress support 329 goes through a range of motion. In one configuration, first lifting portion 330 engages vertical support 312 at slot 336. Second lifting portion 330 engages moving support 338 which is attached to telescoping portion 322.

Exemplary lifting support 324 is capable of a range of vertical motion. The range of vertical motion enabled by lifting support 324 will typically be between 6" and 12". This range of vertical motion provides sufficient clearance for a horizontal transfer from a first bed/cart to a second bed/cart. Thus, retrofitted bed/cart 326 with attached transfer unit 304 can transfer patients from or to retrofitted bed/cart 326. Lifting support 324 also enables workers to change linen more conveniently. However, transfer sheet 302 needs to be changed separately.

Referring to FIG. 19, drive system 310 includes horizontal drive system 340 and vertical drive system 342. Drive system 310 is operated from control panel 344 (FIGS. 18–20). Control panel 344 may be located on vertical supports 312. Alternatively, portable controller 345 (FIG. 23) is patched into head frame 306 or foot frame 308 through connector 348. Other embodiments for controlling drive system 310 are possible. Drive 342 enables vertical motion of lifting support 324. Drive 342 may be adapted to operate by motorized worm drive 343 or by other motor or hydraulic systems.

Two embodiments are shown for horizontal drive system 340 in FIGS. 19 and 21, respectively. The first embodiment includes motor 350. Motor 350 is secured to the frame of bed/cart frame 352. Motor 350 turns drive shafts 352, 354. Drive shafts 352, 354 connect to transmission 356. Transmission 356, in turn, is in mechanical communication with telescoping portion 322. Thus, actuating motor 350 results in extending or retracting telescoping portion 322 within fixed portion 318.

The second embodiment of drive system 340 includes motor 358 mounted on either head frame 306 or foot frame 308. Motor 358 rotates worm drive 360. Worm drive 360 is mounted horizontally alongside motor 358. Worm drive 360 transfers motion from motor 358 to telescoping portion 322. Optional removable panel 362 can be removed, as shown in FIG. 24, and mounted on foot frame 308. When mounted on foot frame 308, panel 362 may be used as a shelf, as a cardiopulmonary resuscitation (CPR) board, or to support additional equipment as shown in FIG. 25.

An appropriate transfer sheet 302 for use in this embodiment of horizontal transfer unit 300 is depicted in FIGS. 27 and 28. Transfer sheet 302 includes wings 380. Hook and loop or comparable fasteners 382 may be present on the edges of wings 380. Wings 380 may be folded over the patient and closed with fasteners 382. The shape of wings 380 may be selected as desired. The top and bottom of transfer sheet 302 may include reinforced attachment portions 384. Reinforced holes, grommets 334, or other improved attachment means are optionally present within reinforced portions 384. Sheet 302 may be attached to sheet clamps 325. Alternatively, sheet 302 may be attached to the clamps shown in FIGS. 8–13. The presence of grommets on sheet 302 may be a disadvantage when sheet 302 is being laundered. Attachment portions 384 will generally extend to or just beyond the end of the mattress 386. Other designs are possible for sheet 302, for example an embodiment which does not fold over the patient.



As depicted in FIGS. 19 and 20, vertical supports 312 and telescoping portion 322 are initially placed in a retracted position if the patient is being moved from retrofitted bed/cart 326. Vertical supports 312 and telescoping portion 322 are initially placed in their extended position if the patient is being moved from a separate bed/cart 331 to retrofitted bed/cart 326. Transfer sheet 302 is optionally folded over the patient, and fasteners 382 are secured together. Attachment portions 384 are placed into opening 332 and sheet clamps 325 engage reinforced holes 334. At this point, vertical drive system 342, originally in its lower point, is engaged to extend to its upper point, thereby raising the patient into a suspended position.

Horizontal transfer system 300 is engaged accordingly to move the patient from an original location to the transfer location. If the patient was originally disposed on retrofitted bed/cart 326, vertical supports 312 and telescoping portion 322 are moved to extended positions. If the patient was not originally located on the retrofitted bed/cart 326, vertical supports 312 and telescoping portion 322 are moved to retracted positions. Once the horizontal transfer is complete, vertical drive system 342 is lowered and transfer sheet 302 is disengaged therefrom.

Another embodiment of a patient transfer device 400 is shown in FIG. 29. Head portion 402 and foot portion 404 may be similar in construction to head frame 304 and foot frame 306, respectively. However, head portion 402 and foot portion 404 lack lifting supports 324 attached to telescoping portion 320. Head portion 402 and foot portion 404 instead include top supports 406. Top supports 406 support upper transverse support 408. Upper transverse support 408 provides support to counterforces resulting from the weight of the patient during a transfer.

Upper transverse support 408 may include transverse tracks 410 on both sides thereof. Transverse tracks 410 support lifting elements 412. Lifting elements 412 include track wheels 414. Track wheels 414 rotate within tracks 410, thereby enabling lifting elements 412 to transverse thereon. Lifting elements 412 may include winches (not shown) to retract cords 416. Cords 416 may have fasteners 418 at their ends for attaching to reinforced holes or grommets 420 at the corners of draw sheet 422. Retracting cords 416 raise draw sheet 422, on which the patient is secured therewithin.

As shown in FIG. 30, extendable horizontal supports 424 may include wheels 428. Horizontal supports 424 enable lateral motion of vertical supports 426, along with upper transverse support 408 and lifting elements 412. As with system 300, device 400 can transfer a patient from a retrofitted bed/cart to a second bed/cart or from a second bed/cart to the retrofitted bed/cart.

An exemplary single lifting element 412 is depicted in FIGS. 31, 32. Element 412 may be used with lift jacket 430. Lift jacket 430 fits around the torso of a patient and includes loops 432. Fasteners 418 attach to loops 432. When thusly attached to lift jacket 430, cords 416 may be retracted, thereby lifting the patient's torso off the bed and into a bent position at the patient's waist. Lifting element 412 may then be translated and rotated as shown in FIGS. 31 and 32, thereby placing the patient in a seated position at the side of the bed. The patient's back is supported in this position. In this way horizontal transfer device 400 serves a second purpose in assisting a patient from a supine to a sitting position.

Exemplary transfer system 500 is depicted in FIG. 33. Transfer system 500 is designed for retrofitting both bed 502 and cart 504. Transfer system 500 includes horizontal trans-

fer mechanism 508 and transfer bridge 510 (FIGS. 37-41). Horizontal transfer mechanism 508 includes docking mechanism 506. FIGS. 34 and 35 depict two representative embodiments of docking mechanism 506. Bed 502 of the first embodiment includes foot board 518. An opening 516 is defined in the side of foot board 518. The first embodiment of transfer system 500 includes spring loaded clamp 512. Clamp 512 includes arms 514, each arm 514 with an angled front edge 524. Arms 514 protrude from opening 516 at side of foot board 518 of bed 502. Spring loaded clamp 512 engages cavity 520, which opens into transfer bar 522. When angled front edge 524 of arms 514 engage cavity 520, arms 514 resiliently deflect towards each other until tips 526 clear flanges 528. When tips 526 clear flanges 528, arms 514 return outwardly as tips 526 engage flanges 528. Arms 514 pivot on docking support 530 within bed foot board 518. Head boards (not shown) of bed 502 and cart 504 have a comparable docking mechanism. When clamp 512 is protruding from opening 516, arms 514 may be disengaged by being pressed together.

The second embodiment of the docking mechanism 506 is depicted in FIG. 35. In this second embodiment, gear 538 is supported by a docking support 540. Gear 538 protrudes from opening 542 in the side of bed foot board 544. Protruding gear 538 engages teeth 548, which are disposed on top surface 550 of cavity 552 within transfer bar 522. Gear 538 may flex slightly on its support 540 to engage teeth 548. Cavity 552 within transfer bar 522 may not have flanges at its opening. Gear 538 is disengaged by pressing downwardly on docking support 540 when docking support 540 is protruding from opening 542. The head boards (not shown) of bed 502 and cart 504 may have a comparable docking mechanism.

The two embodiments of docking mechanisms 506 are described in a particular configuration with respect to the cart and the bed. This configuration may be reversed with the bed containing protruding gear 532 or clamp 512. In either configuration, the protruding gear or clamp may be retracted by worm gear drive 532 during a docking.

Horizontal transfer mechanism 508 is shown in FIG. 36. Transfer mechanism 508 includes transfer element 556 and drive system 558. Transfer element 556 includes gripping mechanism 560 and transfer bar 522. Gripping mechanism 560 grips transfer sheets such as transfer sheet 302. Gripping mechanism 560 is attached to transfer bar 522 by a plurality of support bars 564. Gripping mechanism 560 may be similar to sheet clamp 325. Transfer bar 522 slides within cart channel 566 and bed channel 568. Cart channel 566 and bed channel 568 respectively define slots 570, 572. Support bars 564 extend through slots 570, 572 within cart channel 566 and bed channel 568, respectively. Docking supports 530 or 540 may be moved laterally by drive system 558 which may comprise worm gear drive 532 (FIGS. 34, 35). Worm gear drive 532 includes motor 534 and worm 536. Rotating worm 536 laterally moves docking supports 530 or 540. The motion of the docking supports 530 or 540 moves transfer bar 522 within channels 566 and 568 (FIG. 28). Worm gear drive 532 can move the transfer bar 522 in either direction, thereby effecting a patient transfer in either direction.

Transfer bridge 510 is mounted on the side of cart 504 (FIGS. 37, 41). Transfer bridge 510 includes bridge 574, lever 576 and mounting portions 578. Bridge 574 is preferably molded from a low friction material such as, for example, polypropylene, to facilitate passage of the transfer sheet. It is recognized that other low friction materials may also be suitable. Mounting portions 578 are attached to the



side of cart **504** by rods **580**. Mounting portions **578** include hinge **582** which supports bridge **574**. Lever **576** passes through mounting portions **578**. Rotating lever **576** changes the configuration of hinges **582**, thereby moving bridge **510** between a stored position and a bridge position, as shown in FIGS. **37–40**. In the bridge position, bridge **574** fills in the gaps between bed **502** and cart **504**. In the storage position, bridge **574** may function as a side rail for cart **504**. FIG. **41** depicts a different embodiment of transfer bridge **510**, including split transfer bridge portions **584**. These embodiments of the transfer bridge may be adapted for use with other transfer systems including the conventional manual transfer system.

To transfer a patient between bed **502** and cart **504**, transfer sheet **302** is attached to gripping mechanisms **560** proximate the patient's head and foot, in a similar manner to the attachment of transfer sheet **302** in the embodiment of FIG. **18**. Referring to FIG. **36**, cart **504** and bed **502** are positioned to align channels **566** and **568**. Referring to FIG. **38**, transfer bridge **510** is placed in its transfer position to fill the gap between bed **502** and cart **504**. As shown in FIG. **36**, drive system **558** is engaged to move transfer element **556** from bed **502** or cart **504** where the patient was located to the bed **502** or cart **504** to which the patient is being transferred. Once the patient is transferred, cart **504** and bed **502** are undocked, and transfer sheet **302** is disconnected from gripping mechanisms **560**.

The above transfer systems rely on supporting the patient on some type of sheet during the transfer. However, present methods often rely on health care personnel to provide the necessary transfer forces, usually by pulling a transfer sheet. However, supporting the patient on a sheet may be inappropriate for patients with certain injuries. Hence, it may be safer to transfer the entire mattress or cushion, as described below.

FIG. **42** depicts exemplary bed **600**. Bed **600** includes exemplary mattress transfer system **602**. Bed **600** supports modular mattress **604** and fixed cushion **606**. Modular mattress **604** includes wing **608** made of padded fabric in this example. Wing **608** wraps around fixed cushion **606** to form a smooth surface without gaps, as shown in the insert to FIG. **42**. Wing **608** tucks under modular mattress **604** when not in use. Referring to FIG. **43**, bed **600** connects to cart **610** by way of docking mechanism **612** when mattress **604** is to be transferred. Docking mechanism **612** includes one or more apertures **614** for accepting projections **616**. FIG. **43** displays apertures **614** on bed **600** and projections **616** on cart **610**. However, the opposite arrangement would work similarly. It is possible to provide a locking mechanism (not shown) to lock projections **616** within apertures **614**. The locking mechanism would prevent relative motion of bed **600** and cart **610** during transfer of modular mattress **604**. However, the same effect may be accomplished by locking the wheels of cart **610**.

In one embodiment, mattress transfer system **602** includes transverse bar **618**, a plurality of lateral bars **620** and at least one lateral drive bar **622**. Transverse bar **618** is connected to the plurality of lateral bars **620** and to at least one lateral drive bar **622**. Lateral bars **620** slide along lateral tracks **624**. Lateral drive bar **620** engages lateral drive track **626**. Lateral bars **620** and lateral drive bars **622** allow transverse bar **618** to extend just past the edge of bed **600**. Transverse bar **618** has a plurality of gripping mechanisms **628**. Each gripping mechanism **628** may assume a pushing position (FIG. **44**) and a pulling position (FIG. **45**) for respectively pulling and pushing modular mattress **604**.

Referring to FIGS. **42** and **46**, gripping mechanisms **628** grip handles **630** near the edge of modular mattress **604**.

Mattress transfer system **602** is controlled from control panel **632** mounted on foot board **634**, as shown in FIG. **42**. Actuating mattress transfer system **602** moves transverse bar **618** either toward or away from cart **610** by moving lateral drive bar **622** accordingly. Of course, a variety of designs are possible for the mattress transfer system **602** besides the embodiment described.

Referring again to FIG. **46**, modular mattress **604** may include channel system **636** to accommodate transfer system **602**. Channel system **636** includes transverse void **638** and longitudinal channels **640**. Transverse void **638** accommodates transverse bar **618**. Longitudinal channels **640** accommodate lateral tracks **624** and lateral drive track **626**. Handles **630** are located along an upper surface of transverse void **638**. To the extent necessary, channels **642** may be present within fixed cushion **606**.

In order to transfer modular mattress **604**, cart **610** is first docked with bed **600** using docking mechanism **612**. If modular mattress **604** is being moved to cart **610**, the patient is centered on modular mattress **604**, and gripping mechanisms **628** are set from control panel **632** into a pushing position. Mattress transfer system **602** is then operated to move transverse bar **618** toward cart **610**. When modular mattress **604** is located on cart **610**, docking mechanism **612** is disengaged.

If modular mattress **604** is being moved from cart **610** to bed **600**, cart **610** and bed **600** are docked appropriately. Then, transverse bar **618** is placed into an extended position within transverse void **638**. Gripping mechanisms **628** are placed in their pulling position. Mattress transfer mechanism **602** is operated to move transverse bar **618** away from cart **610**. When modular mattress **604** is in position on bed **600**, mattress transfer system **602** is stopped and docking mechanism **612** is disengaged.

Bed **600** with mattress transfer system **602** may be adapted to cooperate with exemplary position changing cart **650** when used with folding mattress **652**, as shown in FIGS. **47–49**. Position changing cart **650** includes base **654** and a plurality of, preferably two, arms **656**. Base **654** has a plurality of locking wheels **658** to provide a relatively broad base of support for cart **650**. Base **654** should have sufficient weight and a relatively low center of mass such that cart **650** is stable. Top **660** of base **654** provides support for the center of folding mattress **652** when mattress **652** is positioned on cart **650**.

Arms **656** may include support portion **662** and lever portion **664**. Support portions **662** extend laterally toward bed **600** from the far edge of cart **650**. Lever portions **664** are rigidly attached to support portions **662** at one end and are attached to hinge mechanism **666** at base **654**. Support portions **662** support folding mattress **652** when mattress **652** is positioned on cart **650**. A folding drive (not shown) within base **654** is operated from control panel **668** at the side of base **654**. The folding drive operates to rotate hinge mechanisms **666** to change folding mattress **652** from a prone configuration to a seated configuration, or visa versa, as depicted in FIGS. **47,49**.

When going from a supine to a seated configuration, lever portion **664** at the head of mattress **652** rotates upwardly and lever portion **664** at the foot of bed **400** rotates downwardly. Folding mattress **652** may include creases **670** to accommodate changes in configuration. Movement of folding mattress **652** on and off position changing cart **650** is analogous to moving modular mattress **604** on and off cart **610**.

The next devices are designed to hoist, or pull up, a patient disposed on a bed or a chair. These devices are



configured with at least one lifting device and at least one winch system. Exemplary embodiment 700 illustrates a hoist system. Hoist system 700 includes “lobster claw-shaped” bed jacket 702, as shown in FIGS. 50–52. Bed jacket 702 has two “claw” portions 704 joined at joint 706. Claw portions 704 are made of fabric enclosing a padding in one embodiment. Exemplary joint 706 includes folds in the fabric which enable a greater flexibility therein. No portion of bed jacket 702 fits under the mid-torso of a patient. Hence, it is relatively easy to place bed jacket 702 on the patient. Lifting forces generated when bed jacket 702 is used are distributed across the patient’s chest and the patient’s neck is supported by claw portions 704.

Claw portions 704 may display edges 708 at their ends opposite joint 706. Edges 708 may be joined by hook and loop fastener 710, with clips (not shown), as well as other suitable fasteners. However, edges 708 do not necessarily have to be joined before the patient is moved by bed jacket 702. In use, joint 706 is placed across the patient’s chest and claw portions 704 are placed under the patient’s arms. Edges 708 may be joined behind the patient’s neck, if desired. If edges 708 are not joined, they will nonetheless be held together by loops 714. Loops 714, in turn, are attached to a hoist cable as described below.

Bed jacket 702 may be used with at least two embodiments of the winch system described herein. A first embodiment, winch system 712, is depicted in FIG. 52. In this embodiment, bed jacket 702 includes loop 714 for attaching tether 716. Tether 716 winds on external winch 718. External winch 718 may be attached to head board 720, located on support 722. Support 722 may be in an elevated position above a bed or wheel chair 724 (FIG. 53) or mounted to a ceiling (FIG. 52). External winch 718 may be operated manually with a hand crank (not shown) or with a motor (not shown). If present, the motor may be controlled by a control panel.

As shown in FIGS. 54, 55, external winch 712 may also be used with padded vest 762. Exemplary padded vest 762 offers many of the same advantages as lobster claw bed jacket 702. Padded vest 762 includes foam portion 764 and straps 766. Foam portion 764 fits across the patient’s chest. Two adjustable straps 766 extend from foam portion 764. One strap 766 includes head support 768 attached thereto. The free end of head support 768 may be attached with hook and loop fastener 770 or a comparable fastener to the other strap 766. Rings 772 may be attached to the ends of straps 766. Rings 772 attach vest 762 to tether 716. Tether 716 is wound about winch 718.

FIGS. 53, 56–58 depict exemplary winch system 726. Winch system 726 includes bed jacket 730. Winch mechanism 728 is disposed within bed jacket 730. Winch mechanism 728 is preferably motorized. Winch mechanism 728 is embedded in one of claws 732 of bed jacket 730. However, winch mechanism 728 may be imbedded in other designs of bed jackets as well. Exemplary winch mechanism 728 includes motor 734. Motor 734 rotates drive shaft 736. Spool 738 is mounted on drive shaft 736. A first end of tether 740 is attached to spool 738. Ring 742 is attached to the second end of tether 740.

Claw 732 may also include controls such as release switch 744, recoil switch 746, pull switch 748 and lower switch 750. Release switch 744 releases spool 738, allowing tether 740 to be unwound therefrom. Recoil switch 746 winds tether 740 on spool 738 using a spring mechanism (not shown) if there is a sufficiently minimal resistance from tether 740. Pull switch 748 activates motor 734 to wind

tether 740 on spool 738. Lower switch 750 actuates motor 734 in the opposite direction, thereby releasing tether 740 from spool 738. Optionally, controls 744–750 may be disposed externally to bed jacket 730. If so, controls 744–750 may be contained within a remote control unit or mounted to a bed. External control units may communicate with winch mechanism 728 either through a wired or wireless (transmitter/receiver) communication in a similar manner to control unit 278 on the clamp embodiments depicted in FIGS. 15 and 16.

Exemplary ring 742 may be attached to head board 720, to an elevated support on wheel chair 722 or to ceiling mount 52. Thus, motorized bed jacket 730 may be used in the same way as its non-motorized counterpart 702. Winch-bed jacket combination 730 is more versatile because it may be used without separate winches. Furthermore, controls 744–750 are conveniently located. Hence, a health care worker can operate controls 744–750 while being close enough to the patient to assist in the transfer thereof.

Bed jacket 702 may also be connected by way of three axis control cylinder 752 to three ceiling mounted winches 754, as shown in FIGS. 59 and 60. Control cylinder 752 may connect to bed jacket 702 by way of ball 756. Ball 756 fits into ball joint 758. Control cylinder 760 may include three switches 760. Each switch 760 controls motion along one of three axes. Referring to FIG. 61, switches 760 are in electrical communication with microprocessor 753. Microprocessor 753 may be preprogrammed to include the locations of winches 754 in its memory. Thusly programmed, microprocessor 753 may calculate instructions for winches 754 to perform selected motions. Microprocessor 753 may be connected to winches 754 by way of wires 755. This versatile system can be used in a variety of ways including transferring a patient from bed 762 to a wheel chair 724 and pulling the patient up in either bed 762 or wheel chair 724. Padded vest 724 may also be used with three axis control cylinder 752.

FIGS. 62–95 further relate to features of a portable patient transfer system of the present invention. Each component thereof, is consistent with the patient care and health care injury reduction goals stated above. Referring to FIGS. 62–64, exemplary engaging mechanism 800 is shown. Engaging mechanism 800 is designed for engaging or clamping a sheet bearing a patient. Engaging mechanism 800 includes forwardly opening element 802, arcuate engaging element 804, belt engaging element 806 and cylindrical member 807. In this embodiment, elements 802, 804 are elongated and may have a length of at least greater than about 60 cm and preferably at least about 100 cm. Element 802 includes interiorly disposed movable extension 808. A laterally disposed edge, such as convex edge 810, is present on extension 808. Arcuate engaging element 804 displays exterior surface 812 and interior surface 814. Interior surface 814 defines cavity 816. A plurality of belt engaging elements 806 are affixed to element 802. Elements 806 extend through engaging element 804. At least one engaging slot 817 is defined exterior to engaging element 804 on belt engaging element 806. Disposed on each end of element 802 is pivot means 818. Pivoting member 820 is slidingly and rotatably affixed about pivot means 818. Pivoting member 820, in turn, is rigidly affixed to portions of cylindrical member 807. The exterior surface of cylindrical member 807 may be smooth or may present a roughened surface to enhance gripping. A rubberized or tacky substance may be present on the surface of cylindrical member 807. Other means to enhance gripping such as an increased surface area or greater gripping features of the existing surface area may also be



present. A plurality of biasing springs or other biasing means (not shown) are optionally and operably disposed within engaging mechanism **800**.

Functionally, elements **802**, **804** of engaging mechanism **800** are biased away from each other by means one or more biasing springs (not shown). When a user desires to place a transfer sheet within engaging mechanism **800**, the user first wraps a portion of the transfer sheet around cylindrical member **807**. Subsequently, cylindrical member **807** is pivoted proximate convex interior surface **810**. Elements **802** and **804** are then forced toward each other, thereby extending engaging slot **817** on belt engaging element **806** away from element **804**. When elements **802**, **804** are in a closed position, cylindrical member **809** and the portion of the transfer sheet wrapped around cylindrical member **809** are enclosed within clamp **800**. Engaging slot **817** is displaced by forcing elements **802**, **804** toward each other. Hence, when elements **802**, **804** contact and grip cylindrical member **809** and the enwrapped transfer sheet, engaging slot **817** is sufficiently distant from element **804** for belt buckle **822** to firmly latch onto belt engaging element **806**. Belt buckles **822**, when firmly attached onto engaging element **806**, thereby hold elements **802** and **804** in a closed position. Elements **802**, **804** enclose cylindrical member **809** therein and exert a gripping force on the portion of the transfer sheet enclosed. When a patient is being transferred, a transfer force is exerted on belt engaging elements **806**, further forcing elements **802** and **804** toward each other and thus exerting an additional, or further, gripping force on the transfer sheet disposed therein.

Exemplary clamp **830** is shown in FIGS. **65** and **66**. Clamp **830** is another embodiment of the present invention. Clamp **830** includes large U-channel member **832**, small U-channel member **834**, cylindrical member **836**, a plurality of belt engaging elements **838**, and a plurality of cams **840**. Large U-channel member **832** displays outer surface **842**, inner surface **844** and defines a plurality of slots **846**. Each slot **846** is optionally configured with a horizontal and a vertical dimension. Small U-channel member **834** displays outer surface **848** and inner surface **850**. In this embodiment, U-channel members **832**, **834** are at least about 60 cm, preferably greater than about 100 cm, in length. Cylindrical member **836** has a circumference sufficient to enable cylindrical member **836** to fit within the confines of inner surface **846** with a transfer sheet wrapped therearound. Cylindrical member **836** may have a length substantially the same as U-channel members **832**, **834**. The outer surface of cylindrical member **836** may be smooth, but may also be somewhat rough, thereby further facilitating gripping, as described above. Belt engaging elements **838** are rigidly affixed to, and extend from, small U-channel member **834**. Disposed on each belt engaging element **838**, as part of cam attachment element **838**, is engaging means **852**.

In use, a portion of a transfer sheet (not shown) is wrapped around cylindrical member **836**. Cylindrical member **836** and the enwrapped sheet portion are disposed proximate inner surface **850** of small U-channel member **834** and adjacent belt engaging element **838**. Belt engaging elements **838** are then passed through slots **846**. Large U-channel member **832** and small U-channel member **834** are forced toward each other until cylindrical member **836** and the enwrapped sheet contact inner surface **844** of large U-channel member **832**. At this point, the vertical notch component of slots **846** has served as a passageway for cam attachment elements **854**. Cams **840** then lock members **832** and **834** together. Belt buckles or equivalent attaching means (not shown) are then affixed to belt engaging elements **838**.

As in previous embodiments, when a transfer force is exerted on clamp **830**, members **832** and **834** are further forced together, thereby exerting an additional, or further, gripping force on the transfer sheet disposed therein.

Clamps **800** and **830** may be made from resilient, rather stiff materials. Suitable materials include various gauges of metal or synthetic resins. Buckle mechanisms, similar to those commonly used in automobiles, as well as the belts attached thereto, are possible for use as one embodiment of attaching means of the present invention.

Exemplary clamp **860**, depicted in FIGS. **67** and **68**, includes base member **862**, pivoting upper member **864**, two locking levers **866**, locking mechanism **868** and a plurality of belt attachment sites **870**. Pivoting upper member **864** pivots onto base member **862**, with a pivot site at the base of member **864** and coincident with locking mechanism **868**. A rubberized substance **869** or other material with increased tack may be present on the inner surfaces of base member **862** and upper member **864**. A pair of locking levers **866** is present atop base member **862** and proximate the pivotal end of pivoting upper member **864**. Locking mechanism **868** cooperates with locking levers **866** to secure pivoting upper member **864** in a locked position. Pivoting upper member **864** may be biased in an open position by such means as a leaf or helical spring. Two belt attachment sites **870** may be disposed adjacent to each locking lever **866**.

In practice, a portion of a transfer sheet (not shown) is disposed between base member **862** and pivoting upper member **864**. Alternatively, a portion of the transfer sheet may be wrapped around a cylindrical element or other suitable member (not shown), and then placed between base member **862** and pivoting upper member **864**. Pivoting upper member **864** is then pressed toward base member **862** until locking mechanism **868** locks, thereby securing base member **862** and pivoting upper member in a closed, locked position with the transfer sheet gripped securely therewithin. Alternatively, pivoting upper member **864** and locking levers **866** may be mechanically connected by a linkage or lever combination in which locking lever **866** is pressed down by a user, thereby forcing pivoting upper member **864** down until locking mechanism **868** securely locks base member **862** and pivoting member **864** in closed contact. Finally, belt or strap **872** is affixed to clamp **860** by disposing hook **874** within the slots located at belt attachment sites **870**.

As depicted in FIG. **68**, when transfer sheet **876** is secured within clamp **860**, base member **862** and pivoting upper member **864** are in a closed and locked position. When belt **872** is then retracted away from transfer sheet **876**, a transfer force is exerted onto transfer sheet **876** in the direction of arrow **880**. Due to the upper placement of belt attachment sites **870** and the angular configuration of the bottom portion of clamp **860**, a pivot point is thereby formed proximate locking mechanism **868**. This transfer motion simultaneously pivots upper member **864** upwardly and the portion of clamp **860** proximate hook attachment site **870** downwardly, thus rotating clamp **860** about the pivot point located proximate locking mechanism **868** and as indicated in arrow **880**. The angular orientation of the portion of transfer sheet **876**, secured within clamp **860**, relative to the remainder of transfer sheet **876** exerts a further gripping force thereon.

Patient transfer system **900**, as depicted in FIGS. **69–71**, broadly includes bed **902**, cart **904**, motor-winch unit **906**, perpendicular transfer units **908**, **910**, **912**, clamp **914** and a plurality of belts discussed below. Although depicted as cart



904, a bed or other horizontal surface may be used and still be within the spirit and scope of the present invention. Motor-winch unit 906 may be attached to base 916 of bed 902. Perpendicular transfer unit 908 is attached to the upper frame of bed 902. Another perpendicular transfer unit 910 is attached to the upper frame on adjoining cart 904. Still another perpendicular transfer unit 912 is attached to the lower frame of cart 904. As shown in FIG. 69, a pair of belts 918 may extend generally upwardly from motor-winch unit 906 through perpendicular transfer unit 908, finally extending horizontally on mattress 915. Belts 918 are then attached to clamp 914 in any manner such as described herein. Alternately, belts 918 may proceed horizontally from motor-winch unit 906, beneath bed 902 and cart 904 and through perpendicular transfer unit 912. Extending generally upwardly and vertically from perpendicular transfer unit 912, belts 918 pass through perpendicular transfer unit 910, then onto mattress 917. On mattress 917, belts 918 may be attached to a clamp such as a clamp of the present invention. Motor-winch unit 906 may be attached to bed 902 by means of rings 922 extending from housing 920. Rings 922 may enclose an upper portion of casters 924 on which bed 902 is mounted.

In use, bed 902 and cart 904 are aligned and may be secured together. If a patient is to be transferred from bed 902 onto cart 904, clamp 914 is attached to a transfer sheet upon which the patient is disposed. The belts attaching to clamp 914 have been routed under bed 902 and cart 904, then upwards, and then horizontally by means of perpendicular transfer units 910 and 912. Once motor-winch unit 906 is activated, belts 918 are retracted. The transfer force exerted thereby will transport the patient in the direction of arrow 926 from bed 902 onto cart 904. Once the patient has been transferred onto cart 904, motor-winch unit 906 is disengaged. Alternatively, a sensing device (not shown) may be attached to perpendicular transfer unit 910. This sensing device may be either mechanical, electronic, magnetic, optical or a combination thereof in its operation and may detect the presence of the patient, the buckle, the belt portion proximate the buckle, or the clamp within a predetermined distance from perpendicular transfer unit 910.

If the patient is to be transferred from cart 904 onto bed 902, belts 918 are routed through perpendicular transfer unit 908 and onto mattress 915 where they are attached to clamp 914. Clamp 914 is then securely attached to a transfer sheet upon which the patient is disposed. Motor-winch unit 906 is then activated, thereby retracting belt 918 in the direction of arrow 930, thereby generating a transfer force upon clamp 914. The transfer force acts upon the transfer sheet upon which the patient is disposed, thereby transferring the patient from cart 904 onto bed 902 and thereby further, or additionally, gripping the transfer sheet secured within clamp 914. Again, patient proximity sensing devices may be included in perpendicular transfer unit 908 as discussed hereinabove. Perpendicular transfer units 908, 910, and 912 may include either a pulley system or a roller system onto which belts 918 are emplaced prior to a patient transfer. Clamp 914 may be any of the clamps disclosed herein. Some exemplary embodiments of motor-winch unit 906 are discussed in more detail herein.

Referring to FIGS. 72-74, exemplary patient transfer system 940 is depicted. Patient transfer system 940 broadly includes bed 942, portable transfer unit 944 and clamp 946. Bed 942 includes mattress 948 and side rail 950. Side rail 950 may include a plurality of horizontal bars 951. Portable transfer unit 944 includes housing 952, one or more belts 954, an equal number of attaching means or buckles 956 and

a motor-winch unit. Further included in portable transfer unit 944 is mounting bracket 958 which will be further described below. Handle 960 on portable transfer unit 944 enables an attendant to easily grasp and carry portable transfer unit 944 as desired. Housing 952 is preferably a light weight resilient plastic or other suitable light weight material. Portable transfer unit 944 has the advantage of being light in weight, hence readily transportable by an attendant of virtually any size and lifting ability with little likelihood of injury therefrom. Portable transfer unit 944 may weigh between about 20 and 35 pounds. Portable transfer unit 944 may also weigh between about 15 and 25 pounds.

FIGS. 73 and 74 depict two of many possible embodiments 966, 968 of control units 966, 968. Control units 966, 968 control the operation of exemplary portable transfer unit 944. Controls 970 of control units 966, 968 serve to operate portable transfer unit 944. Control unit 966 may communicate with portable transfer unit 944 by means of electromagnetic radiation, more particularly by radio frequency, or by other means. Controls 970 include on/off simultaneous transfer power control 974 and left and right transfer actuator controls 976, 977. Control unit 968 communicates with portable transfer unit 944 by means of a cord or other suitable connecting means. The cord is mechanically and electrically attached to control unit 968 and may be disposed on a spool or other retaining means within portable transfer unit 944. The spool may be biased so that cord 974 winds thereon when control unit 968 is released by the operator. Control units 966 and 968 may be housed in a recess contained within portable transfer unit 944 when not in use. An alternative to the control units of this patient transfer system is via voice actuation. Voice actuation would enable the patient to effect the patient's own transfer and to halt a transfer in progress if the need to do so arose.

FIG. 75 depicts another embodiment of a portable transfer unit according to the present invention. In this embodiment, shaft 978 extends laterally from housing 952. By being exposed, shaft 978 facilitates mounting spools 980 thereon. Spools 980 provide means upon which belts 982 are wound. Since shaft 978 is exposed, each spool 980 may be easily and quickly detached from shaft 978 to facilitate cleaning and disinfecting shaft 978, spools 980 and belts 982.

Exemplary portable transfer unit 944' is depicted in FIG. 93. In this embodiment, receiving cavity 962 is formed in lateral portions of housing 952'. A drive shaft (not shown) is disposed within cavity 962. Spool 980' may be reversibly mounted on the shaft drive. Belt 988 is routed through slot 963 so that buckle 956 may be used to engage a clamp. Cap 964 may be used to cover cavity 962.

Referring again to FIGS. 72-76, bed 942 and exemplary portable transfer unit 944 are depicted. Portable transfer unit 944 is secured to side rail 950 by means such as those described below. Bed 942 is then placed beside a bed or cart onto which a patient is disposed upon a transfer sheet. The transfer sheet is then secured proximate the patient with clamp 946. Belts 954 are then extended from portable transfer unit 944 and attached to clamp 946. Either control unit 966 or 968 is detached from portable transfer unit 944 and used to operate the motor-winch within unit 944 by means such as on/off controls 974. Upon actuation of the motor-winch mechanism, transfer unit 944 begins to wind belts 954 and thereby move clamp 946, the transfer sheet, and the patient toward transfer unit 944. The motor-winch assembly may cease operation when the attendant operates control unit 966, 968 or when an above-described sensing device functions.



During transfer, it is desirable that the longitudinal axis of the patient be generally parallel to the longitudinal axis of the bed or cart onto which transfer is to be effected. If not, the patient may not be transferred completely onto the bed or cart and may require further manual adjustment by the attendant, possibly obviating some of the advantages of this system. Thus, left or right transfer actuator controls **976**, **977** may be used. For example, if left control **976** is actuated, the belt **982**, attached toward the patient's head, continues to be wound and the other belt **982** either ceases to be wound or is wound more slowly. In a similar manner, when right control **977** is actuated, belt **982**, attached closest to the patient's feet, continues to be wound and the other belt **982** either ceases to be wound or is wound more slowly.

When patient transfer is complete, patient transfer system **940** may be disengaged from the transfer sheet and detached from bed **942**. Belts **954** may then be retracted until attached clamp **946** is proximate portable transfer unit **944**. Control unit **968** (or **966**) is then stowed within a niche in portable transfer unit **944**. The attendant then grasps handle **960** and carries portable transfer unit **944** and attached clamp **946** to another location (FIG. **95**), or shows the unit on the cart or bed for subsequent use.

Exemplary portable transfer unit **984** is depicted in FIG. **76**. In this embodiment, belt **986** is bound onto spool **988**. Spool **988**, in turn, is detachably mounted onto bracket **990**. Bracket **990** is mounted onto the back of housing **952**. Bracket **990** includes upper member **992** and lower member **994**. An automatic sensing and motor disconnect may be included in this, as well as other, embodiments. The sensing mechanism detects the presence of either the patient, the clamp, or the terminus of an attached belt. Upon sensing one or more of these, portable transfer unit **984** ceases to wind belt **988**, thereby stopping or easing (slowing) patient transfer.

The portable devices, as well as the other devices of the present invention, preferably also contain an automatic recording and/or display mechanism **998**, representatively shown in FIG. **77**. Mechanism **998** records each patient transfer event. Recording is via a printout on paper or other means. Recording may also comprise storage or transfer of relevant information electronically. The stored information may then be transferred to a computer or other device as desired. Relevant information with regard to a transfer event may include the time of day, the patient's number and name, the attendant's name and number, and the time length of the transfer event. Other items, such as motor performance and torque received by the motor-winch assembly, speed, acceleration, alignment, or other parameters of the patient or the clamp when transferring the patient may also be recorded.

Referring to FIGS. **77** and **78**, exemplary patient transfer system **1000** broadly includes bed **1002** and portable transfer unit **1004**. Bed **1002** includes mattress **1006** and side rail **1008**. Portable transfer unit **1004** includes housing **1010**, control unit **1012**, belts **1014** and an engaging mechanism, such as clamp **1016**. Belts **1014** and clamp **1016** may include any of the embodiments discussed herein. Portable transfer unit **1004** combines a housing which encloses the motor and winch assembly and which is easily and reversibly mounted onto side rail **1008**. Mounting bracket **1018** may be integral to housing **1010** of portable transfer unit **1004**. Mounting bracket **1018** readily and securely mounts onto side rail **1008**. A side view of one embodiment of mounting bracket **1018** is depicted in FIG. **78**. While shown as unitary to the embodiment of FIG. **77**, the concept depicted in FIG. **78** is applicable to any of the portable transfer units of the present

invention. Mounting bracket **1018** includes engaging side **1020** of portable transfer unit housing **1010**, horizontal extension **1022** and substantially vertical member **1024**.

In use, portable transfer unit **1004** is situated onto side rail **1008** such that the lower surface of horizontal extension **1022** rests on side rail **1008**. Pin **1026** is then inserted in opening **1027**, extending through member **1024** and into a slot or receiving orifice **1028**, securely fastening therein. Mounting bracket **1018**, thereby securely holds portable transfer unit **1004** onto side rail **1008** during a transfer event. Moreover, transfer unit **1004** is easily detachable from side rail **1008** by removing pin **1026**.

An end view of another embodiment of a portable transfer unit **1004'** is depicted in FIG. **94**, where an alternate mounting bracket **1018'** is disclosed. Mounting bracket **1018'** includes horizontal extension **1022'** extending integrally from housing **1010'**. Extending generally vertically from horizontal extension **1022'** are fixed upper vertical member **1030** and pivotally mounted, lower vertical member **1032**. A locking mechanism, actuated by cam lever **1034**, is included. To install portable transfer unit **1004'** on a bed with side rails **1008**, portable transfer unit **1004'** is tilted, allowing upper vertical member **1030** to be disposed such that an upper side rail is between member **1030** and housing **1010'**. Lower vertical member **1032**, extended in an open position, allows portable transfer unit **1004'** to be disposed in position and lower side rails **1008** to be disposed proximate housing **1010'**. Lower vertical member **1032** is pivoted to a closed position, generally coaxial to that of upper vertical member **1030**. Finally, cam lever **1034** is pivoted into a locked position in the direction of arrow **1036**.

In FIGS. **79** and **80**, another embodiment of a self-contained portable transfer unit **1040** of the present invention is depicted. Portable transfer unit **1040** broadly includes handle-control unit **1042**, housing **1044**, clamp **1046**, belt **1048**, hook **1050**, and locking devices **1052**. Portable transfer unit **1040** is self contained, including a belt, clamp, and enclosed motor-winch assembly. The motor-winch assembly of portable transfer unit **1040** may be totally enclosed within housing **1044**. Belts **1048** may be extended to hook onto the framework of a bed or cart or they may be retracted to a position almost completely within housing **1044**. Locking devices **1052** may be embodiments previously discussed with respect to the clamps of the present invention. Handle-control unit **1042** may be detached during a transfer event. Handle-control unit **1042** may include controls **1056** disposed within housing **1058**. Alternatively, handle-control unit **1042** may include the controls depicted in FIGS. **73**, **74** and discussed hereinabove. Cord **1054** physically and electrically connects control unit **1042** to the remainder of portable transfer unit **1040**. Cord **1054** may be mounted to a pulley within housing **1044** so that cord **1054** is retracted unless pulled away by a user. Clamp **1046** may open downwardly to admit a transfer sheet therein.

In use, portable transfer unit **1040** is placed onto a bed, onto which a patient to be transferred is disposed upon a sheet. As shown in FIGS. **79-84**, locking devices **1052** are unlocked and the jaws of clamp **1046** are separated. A portion of the transfer sheet is placed between the jaws of clamp **1046**, the jaws are then closed and locking devices **1052** locked. Belts **1048** are extended away from portable transfer unit **1040**, across the bed or cart onto which the patient is to be transferred and hooks **1050** are hooked onto the bed frame. The attendant detaches handle-control unit **1042** and then begins the transfer by actuating the motor-winch assembly. When the patient has been transferred onto the desired bed or cart, the attendant turns the motor-winch



off. The transfer sheet is then freed from clamp **1046** and hooks **1050** are unhooked from the bed and retracted within housing **1044**. Finally, handle-control unit **1042** is reconnected to portable transfer unit **1040**. The attendant then may carry portable transfer unit **1040** away by grasping and holding handle-control unit **1042**.

In FIGS. **81** and **82**, other embodiments are shown for securing the clamps of the present invention. Referring to FIG. **81**, clamp **1070** is secured in a closed position by the operation of clip **1072**. Clamp **1070** includes lower pivoting member **1074** and upper clamp member **1076**. Clip **1072** includes free end **1078** and pivot **1080**. When in an open position, free end **1078** has been pivoted away from the body of clamp **1070** and lower pivoting member **1074** is pivoted away from upper clamp member **1076**. Functionally, a transfer sheet (not shown) is placed between lower pivoting member **1074** and upper clamp member **1076**. Lower pivoting member **1074** and upper clamp member **1076** are then pressed together. Free end **1078** is then pivoted toward the body of clamp **1070**, then snapped around the front thereof. A locking mechanism is thereby actuated, locking lower pivoting member **1074** and upper clamp member **1076** securely together and gripping the sheet therewithin.

Clamp assembly **1088** is shown in FIG. **82** includes clamp **1090** and locking assembly **1092**. Clamp **1090** further includes upper pivoting clamp member **1094** and lower clamp member **1096**. Locking assembly **1092** includes handle **1098**, which actuates the locking mechanism of clamp assembly **1088**. Handle **1098** is affixed to the remainder of locking assembly **1092** via an elongated member. Handle **1098** and the elongated member are slidable within slot **1100**. When clamp assembly **1088** is in an open position, upper pivoting clamp member **1094** is pivoted away from lower clamp member **1096** and handle **1098** is disposed toward rear edge **1102** of clamp **1090**. In use, a transfer sheet is placed between upper pivoting clamp member **1094** and lower clamp member **1096** and clamp members **1094**, **1096** are pressed together, firmly securing the transfer sheet within. Handle **1098** is then grasped by the attendant and pushed away from rear edge **1102**, thereby activating locking assembly **1092** and securing upper pivoting clamp member **1094** and lower clamp member **1096** together in a secure, closed position.

FIG. **83** is a side view of a self-contained portable transfer unit **1110**. Portable transfer unit **1110** may include any of the self-contained portable transfer units described herein. Included are upper clamp member **1112** and lower pivoting clamp member **1114**. When pivoted between an open and a closed position, lower pivoting clamp member **1114** may be moved in either direction as indicated by arrow **1116**.

FIG. **84** depicts self-contained portable transfer unit **1120**. In addition to other features described for the self-contained portable transfer unit embodiments herein, transfer unit **1120** includes upper pivoting clamp member **1122**, lower clamp member **1124** and housing **1126**. Venting **1128** is present within housing **1126**. As indicated by arrow **1130**, upper pivoting clamp member **1122** pivots upwardly toward an open position or downwardly toward lower clamp member **1124** when in a closed position. Venting **1128**, present in housing **1126**, facilitates air exchange and, consequently, enhances cooling of the motor-winch assembly within portable transfer unit **1120**.

FIGS. **85** and **86** disclose one embodiment of motor-winch assembly **1150** of the present invention. Motor-winch assembly **1150** broadly includes frame **1152**, upon which are mounted motor bracket **1154**, control board **1156**, hook

member **1158**, right clutch bracket **1160** and left clutch bracket **1162**. Motor **1164** is operationally mounted on an upper portion of motor bracket **1154**. Gear **1166** (which in one embodiment is a 42-tooth gear) is attached to a shaft (not shown) extending from motor **1164**. Gear **1166**, in turn, operably engages gear **1168** which is mounted on shaft **1169**. Also mounted on shaft **1169** are right clutch **1170** and left clutch **1172**. Right clutch **1170** is disposed within right clutch bracket **1160**. Left clutch **1172** is disposed within left clutch bracket **1162**. Spring **1174** is disposed about right clutch **1170** and about left clutch **1172**. Spring **1174**, in turn, is enclosed by spring cover **1176**. Spring cover **1176** is attached to spring hub **1178**. A spring hub **1178** is affixed to right clutch bracket **1160** and left clutch bracket **1162**. Spool **1182** may be detachably disposed on the outboard portion of shaft **1169**. Motor-winch assembly **1150** is suitable for providing the necessary power to operate the transfer units described herein.

Optimized patient transfer requires smooth transition of the patient from one platform to another. One means for achieving such optimization is through use of a transfer bridge **1200**, shown in FIGS. **87-90**. A modified transfer bridge **1200'**, depicted in FIG. **87**, differs from transfer bridge **1200**. Transfer bridge **1200** broadly includes one or more sections **1202**. A stabilizer **1204** is ideally present on the underside of each section **1202**. Where multiple sections are used, such sections **1202** are joined by hinge **1206** (discussed hereinbelow), and stabilizer **1204** extends generally perpendicularly from each section. Functionally, transfer bridge **1200** is placed between a bed or cart onto which a patient is lying and another bed or cart onto which the patient is to be transferred. Stabilizer **1204** is disposed between the platforms, thereby securely holding transfer bridge **1200** in place and preventing transfer bridge **1200** from being displaced by patient contact during a transfer. After use, transfer bridge **1200** is folded along hinge **1206** for storage or transport.

One embodiment of hinge **1206** is depicted in FIG. **89**. Hinge **1206** may be manufactured as a "living hinge," i.e., a hinge made by removing a narrow, linear portion of the material along a portion of transfer bridge **1200** or transfer bridge **1200'**.

Transfer bridge **1200'**, shown in FIG. **88**, includes a plurality of sections **1202'** and a stabilizer **1204'**, mounted on the underside of each section **1202**. As in the case of transfer bridge **1200**, hinge **1206** is present and divides **1202**. Leading edge **1210** is present on the portion of transfer bridge **1200'** opposite stabilizers **1204'**. Although not depicted, transfer bridge **1200** and **1200'** may include one or more carrying handles. The carrying handles may be attachable, unitary to transfer bridge **1200**, **1200'** or may be cutouts within sections **1202** or **1202'**. Preparing transfer bridge **1200'** for a patient transfer is essentially done in an identical manner as preparing transfer bridge **1200**, the only exception being that leading edge **1210** is oriented toward the patient to be transferred.

Both transfer bridge **1200** and **1200'** may be constructed using a smooth polyethylene sheet material, which is generally about 1.5 millimeters in thickness. Alternatively, hinge **1206** may be reinforced with a thin sheet of polyethylene on the underside of transfer bridge **1200**, **1200'**. Stabilizer **1204'** may be centered about 7.5 centimeters from edge **1214**. One embodiment of transfer bridge **1200'** is about 31 centimeters wide at hinge **1206**, tapering to about 25 centimeters in width at each end. The cambered radius for a side section of transfer bridge **1200'** is about 105 centimeters. The cambered radius for the leading edge of transfer



bridge 1200' is about 225 centimeters. The side camber insures that leading edge 1210 will firmly contact the mattress on which the patient is disposed such that transfer bridge 1200' will not be displaced during a patient transfer. The leading edge camber allows for a gradually increasing amount of patient contact during transfer, rather than immediate total contact. The gradually increasing contact also tends to allow the patient to be pulled atop transfer bridge 1200', rather than abutting and possibly displacing transfer bridge 1200'. Transfer bridge 1200' is advantageously positioned when leading edge 1210 is placed under at least a portion of the patient.

In an average male patient, approximately 90% of the patient's weight resides in the portion between the patient's buttocks and shoulders. Hence, the overall length of transfer bridge 1200 or 1200' should minimally provide support therefor. Accordingly, lengths for transfer bridge 1200 or 1200' may be between 65 and 173, centimeters or about 65, 120 and 173 centimeters.

Clamp 1230 is yet another embodiment of an engaging means for use with this invention. Clamp 1230 is depicted in FIGS. 91 and 92. Clamp 1230 broadly includes U-channel member 1232 and pivot assembly 1234. Pivot assembly 1234, in turn, includes pivot member 1236 and pivot rod 1238. Defined laterally on each end of pivot member 1236 is pivot point orifice 1240. Tab 1241 is laterally present proximate pivot point orifice 1240. Symmetrically affixed to pivot member 1236 is a plurality of belt engaging elements 1242. Each belt engaging element 1242 generally includes tongue section 1244 and planar member 1246. Each tongue section 1244 defines engaging slot 1245. Tongue section 1244 and planar member 1246 are joined in a stair step fashion. A pair of pivot rod brackets 1248 may be laterally attached to pivot member 1236 by means of a rivet or bolt. Orifice 1249 is defined by each pivot rod bracket 1248 and provides the opening through which pivot point 1240 may be disposed. At least one cylindrical member 1250 is affixed to each pivot rod bracket 1248. U-channel member 1232 may include a plurality of slots 1252 and a plurality of brackets 1254. U-channel member 1232 displays leading edge 1256 and inner surface 1258, discussed hereinbelow. Mounted on brackets 1254 is a plurality of cam levers 1260 and springs 1262.

Operationally, a portion of transfer sheet 1263 is wrapped about cylindrical member 1250. Cylindrical member 1250 and the enwrapped portion of transfer sheet 1263 are then pivoted in the direction of arrow 1264 until brackets 1248 rest upon tabs 1241. Slots 1252 on U-channel member 1232 are aligned with belt engaging elements 1242. U-channel member 1232 and pivot assembly 1234 are then pressed together, thus allowing belt engaging elements 1242 to pass through slots 1252 and protrude forwardly therefrom. U-channel member 1232 and pivot assembly 1234 may be biased away from each other by means of a plurality of springs. Another alternative embodiment of clamp 1230 employs a spring (not shown) to bias cylindrical member 1250 in an open position. Cam levers 1260 are then rotated over pivot member 1236, thereby biasing pivot member 1236 against U-channel member 1232 and cylindrical member 1250 firmly against inner surface 1258. Finally, a belt buckle may be affixed to belt engaging elements 1242. Leading edge 1256 of U-channel member 1232 is may be arcuate in cross-section, thereby allowing clamp 1230 to be more positively pulled upon a transfer bridge during a patient transfer, rather than abutting and displacing the transfer bridge.

Referring to FIGS. 96-97, exemplary patient transfer system 1300 enables a single operator to transfer or reposition

a patient disposed on a substantially pliable underlayment, such as a transfer sheet described herein. Patient transfer may be effected from a first horizontal surface to a second horizontal surface or from a first transfer position to a second transfer position. This invention may also advantageously and ergonomically reposition a patient disposed on a substantially pliable underlayment, for example, from a slumped position to a position more toward the head of the bed on which the patient is disposed. Embodiments of this invention may further enable a single operator to ergonomically roll or reposition a patient, for instance, from the patient's left side to the patient's right side (a rollover). Patient transfer is effected with minimum risk of back injury to the operator. Moreover, patient transfer system 1300 is compact, easily transported to and from the site of a transfer event, and self-contained.

Moreover, patient transfer system 1300 is compact and thus easily fits through hospital and elevator doors and other small spaces. A single attendant may easily roll patient transfer system 1300 to the site of a patient transfer, conduct the patient transfer, then roll patient transfer system 1300 to the site of another transfer or place of storage. Patient transfer system 1300 is self-contained in that every component necessary to transfer a patient disposed on a sheet from a first horizontal surface to a second horizontal surface is self-contained.

As seen in FIGS. 96-99, 134, patient transfer system 1300 broadly includes transfer caddy 1302, transfer bridge 1304, and transfer rod 1306. Transfer caddy 1302, in turn, includes head assembly 1308, hook and web assembly 1310, base assembly 1312 and electrical and switching system 1314.

Referring to FIGS. 98, 114, head assembly 1308 includes top frame 1316, power train 1318, and upper shield assembly 1320. Top frame 1316 includes front panel 1322, base panel 1324, motor bracket 1326, retractor bracket 1328, left clutch bracket 1330, a pair of interlock switch brackets 1334, and right clutch bracket 1336.

Front panel 1322 includes lobes 1342 which extend laterally from upper edges of front panel 1322. Lobes 1342 and front panel 1322 cooperate in defining generally rectangular openings 1344. Front panel 1322 presents planar inner surface 1346. Base panel 1324 extends generally transversely from a bottom edge of front panel 1322. Base panel 1324 presents upper surface 1348. A pair of laterally disposed peripheral lips 1350 extend upwardly from a rear edge of base panel 1324. Arcuate extension 1352 is a rearward extension of base panel 1324 and is flanked by peripheral lips 1350.

Motor bracket 1326 includes planar member 1354, a lateral pair of generally perpendicular members 1356, and generally perpendicular lower member 1358. Motor bracket 1326 is affixed to top frame 1316. More specifically, one of members 1356 is affixed to surface 1346 and lower member 1358 is affixed to surface 1348.

Retractor bracket 1328 includes horizontal member 1362 and vertical member 1364. Vertical member 1364 extends upwardly and generally transversely from horizontal member 1362. A generally cylindrical or conical element 1365 extends from vertical member 1364 generally toward right clutch bracket 1336. Retractor bracket 1328 is affixed to top frame 1316 slightly to the right and rearwardly from motor bracket 1326. Motor bracket 1326 defines orifices 1366, 1368, 1370 and cutout 1372. Orifice 1366 is defined generally centrally on planar member 1326. Orifice 1368 is defined generally below orifice 1366. One or more smaller orifices 1370 may also be defined within planar member



1354. Generally arcuate cutout 1372 may be defined proximate a central portion of an upper edge of member 1354.

Left clutch bracket 1330 generally includes inboard planar member 1376, outboard planar member 1378 and connecting member 1380. Front edges of inboard planar member 1376 and outboard planar member 1378 are unitary to connecting member 1380 and are joined at a bend in this embodiment. Inboard planar member 1376 defines central orifice 1382 and one or more smaller orifices 1384. Orifices 1384 may be peripherally disposed with respect to central orifice 1382. Outboard planar member 1378 defines opening 1388, cutouts 1390, opening 1392, cutout 1394, and generally rectangular opening 1396. Opening 1388 is generally circular, with four cutouts 1390 extending generally radially therefrom. Opening 1392 is defined above a rear portion of opening 1388. Generally arcuate cutout 1394 is defined proximate an upper edge of outboard planar member 1378. Rectangular opening 1396 is disposed generally centrally, below clutch opening 1388. A plurality of smaller openings 1398, flanking opening 1396, may also be defined by planar member 1378.

Interlock switch bracket 1334 is disposed proximate openings 1344 and affixed to front panel 1322 proximate surface 1346.

Right clutch bracket 1336 generally includes inboard planar member 1400, outboard planar member 1402 and connecting member 1404. Front edges of inboard and outboard planar members 1400, 1402 may be unitarily joined to connecting member 1404 at a bend. Orifices defined within inboard planar member 1400 and outer planar member 1402 are generally similar to those formed or defined by inboard planar member 1376 and outboard planar member 1338. Therefore, these openings are designated by identical numerals.

Motor bracket 1326 is mounted such that planar member 1354 is generally transverse to panels 1322, 1324. Inboard planar members 1376, 1400, outboard planar members 1378, 1402, and vertical member 1364 are disposed generally parallel to planar member 1354 in this embodiment.

Front panel 1322, base panel 1324, motor bracket 1326, retractor bracket 1328, left clutch bracket 1330, interlock switch brackets 1334, and right clutch bracket 1336 may be formed from a 16–18 gauge sheet metal. However, other suitable materials are known to the art.

Also as seen in FIGS. 98, 114, power train 1318 broadly includes motor 1410, motor gear 1412, shaft gear 1414, shaft bearing 1416, shaft 1418, and pluralities of magnetic clutch assemblies 1420, slip plates 1422, and drum assemblies 1424. Motor 1410 includes housing 1430 and motor shaft 1432. Motor shaft 1432 may define a key way (not shown). A generally coaxial bore 1434 is defined in motor gear 1412. Bore 1434 accommodates motor shaft 1432. Gear 1412 may be further affixed to motor shaft 1432 by means of a key (not shown) inserted in the key way. Motor 1410 may be affixed to motor bracket 1326 by fasteners, such as a plurality of screws. When motor 1410 is attached to motor bracket 1326 and motor gear 1412 is mounted on motor shaft 1432, motor shaft 1432 extends through motor orifice 1368 and motor gear 1412 is disposed outboard planar member 1354. When power train 1318 is assembled, shaft 1418 extends through orifices 1366, 1382, and 1388.

Shaft gear 1414 may be mounted on shaft 1418 in a similar manner as motor gear 1412 is mounted on motor shaft 1432. Shaft gear 1414 may further be disposed on shaft 1418 such that shaft gear 1414 meshes with motor gear 1412. Shaft 1418 extends through shaft bearing 1416 when

power train 1318 is assembled. Shaft bearing 1416 may be further affixed to planar member 1354 by fasteners, such as a plurality of screws 1433. In one embodiment, gears 1412, 1414 respectively possess thirty-sixty and forty teeth. Gears 1412, 1414 may be formed from such materials as steel, cast iron, as well as from other materials known to the art. Shaft 1418 may be formed from similar materials as gears 1412, 1414. In this embodiment, motor 1410 is a permanent magnet, parallel shaft, DC brush gear motor, operating at 12 volts DC and generating approximately 1/8 hp. Also in this embodiment, motor 1410 rotates motor shaft 1432 at an output speed of between about 25 and 75 rpm and attains an output torque range of between approximately 300 in-lbs at 25 rpm and 100 in-lbs at 75 rpm. Motor 1410 may be approximately 10" ( $\pm 0.5$ ") long, 5" ( $\pm 0.5$ ") high, and 4" ( $\pm 0.5$ ") wide. An exemplary motor may be obtained from Byson Gear and Engineering Corporation, Downers Grove, Ill.

Each magnetic clutch assembly 1420 includes disk 1436 and cylindrical housing 1438. A generally coaxial bore 1440 extends through magnetic clutch assembly 1420. In this embodiment, bore 1440 has a 1/2" diameter and disk 1436 has a diameter of approximately 4.9" ( $\pm 0.5$ "). Cylindrical housing 1438 has a diameter of approximately 4.2" ( $\pm 0.5$ ") and a height of approximately 1.8" ( $\pm 0.5$ "). An exemplary magnetic clutch develops a torque of 22 lb-ft, and attains a coil power of 28 watts, an armature hub inertia of 161 $\times 10^{-4}$  lb-ft<sup>2</sup>, a rotor inertia of about 172 $\times 10^{-4}$  lb-ft<sup>2</sup>, and generates 3 hp at 1800 rpm. Disk 1436 may be mounted to an outboard surface of inboard planar member 1376 by fasteners, such as a plurality of screws. When magnetic clutch assembly 1420 is mounted to inboard member 1376, cylindrical housing 1438 extends through opening 1388. Magnetic clutch assembly 1420 is mounted such that shaft 1418 extends generally coaxially through bore 1440. Shaft 1418 and magnetic clutch 1420 may be affixed by a key way combination (not shown). Each slip plate 1422 defines bore 1466, a plurality of peripheral holes 1446, and presents an inboard surface 1444.

Each exemplary drum assembly 1424 includes cylindrical member 1450. Four threaded extensions 1452 may extend peripherally from cylindrical member 1450. Disk 1454 may be unitarily joined to cylindrical member 1450. Disk 1454 presents an outboard surface 1455 and defines a threaded aperture 1456. Cylindrical member 1457 coaxially extends from outboard surface 1455. Outboard disk 1458 extends generally coaxially and radially from the outboard terminus of cylindrical member 1457. Outboard disk 1458 defines an aperture 1460 and presents an outboard surface 1462. Aperture 1460 is generally aligned with threaded aperture 1456 in this embodiment.

Also in this embodiment, a fastener such as a screw extends through each aperture 1446 and is threadably disposed within each threaded extension 1452. Screw 1464 is extended through aperture 1460 and is threadably received within threaded aperture 1456 as will be discussed below. Bores 1466, 1468 are coaxially formed within slip plate 1422 and drum assembly 1424, respectively, such that shaft 1418 is received within bores 1466, 1468. Drag cap spring 1470 is compressibly held in place by drag cap 1472 cooperating with a fastener such as a screw. If a screw is used, the screw is threadably received within an aperture proximate a terminus of shaft 1418.

As seen in FIGS. 96, 98, upper shield assembly 1320 includes upper shield 1478 and respective left, and right end caps 1480, 1482. Upper shield 1478, in turn, includes front panel 1486, upper panel 1488, and rear panel 1490. Front



panel 1486 includes conical protrusion 1492. Respective planar members 1493, 1494 flank protrusion 1492 and present an interior surface 1496. Lower lip 1498 extends generally transversely from interior surface 1496, proximate a lower edge thereof. In this embodiment, upper panel 1488 includes planar member 1502 and presents upper surface 1504. Planar member 1502, in turn, defines switch aperture 1506, on-off light aperture 1508, and charge light aperture 1510. Apertures 1506–1510 are generally and centrally aligned transverse a longitudinal axis of planar member 1502. Rear panel 1490 includes respective left and right planar members 1514, 1516. Conical protrusion 1518 unitarily extends from, and is flanked by, left and right planar members 1514, 1516. An upper edge of rear panel 1490 unitarily joins a rear edge of upper panel 1488 at a bend. Upper and rear panels 1488, 1490 cooperate in defining remote aperture 1522. Remote aperture 1522 generally aligns with apertures 1506–1510 and extends downwardly into a portion of conical protrusion 1518.

Another lower lip (not shown) protrudes from an interior surface of rear panel 1490 in a similar manner as lower lip 1498. Extending from respective left and right edges of panels 1486–1490 are left and right peripheral extensions 1524, 1526, respectively. Extensions 1524, 1526 are formed by inward recesses from the exterior edges of panels 1486–1490.

Respective left and right end caps 1480, 1482 are essentially mirror images in this embodiment. Hence, they will be described with like-numbered elements. Each end cap 1480, 1482 includes an outboard member 1530, an upper member 1532 and a rear member 1534. Outboard member 1530 is generally arcuate in cross-section. Upper member 1532 further includes generally planar member 1536 and generally conical element 1538. Element 1538 extends above a forward portion of planar member 1536. Lip 1540 extends forward from a lower edge of rear member 1534.

Referring to FIGS. 98, 114–120, hook and web assembly 1310 includes web 1550 and transfer hook 1552. First and second loops 1556, 1558 are formed within web 1550 by stitching 1560. In this embodiment, transfer hook 1552 is a unitary structure, which includes strap retaining member 1564 and hook member 1566. Strap retaining member 1564, in turn, displays exterior surface 1565 and defines a generally cylindrical bore 1568. A slot 1570 is further defined in a lower portion of strap retaining member 1564. Extending from strap retaining member 1564 is flange 1572. Flange 1572 displays lower surface 1573. Hook member 1566 extends from an upper portion of strap retaining member 1564. Hook member 1566 may be envisioned as including planar member 1574, arcuate member 1575, and terminal lip 1576. Planar member 1574 extends from strap retaining member 1564. Arcuate member 1575 extends from planar member 1574. Terminal lip 1576 extends from arcuate member 1575 toward strap retaining member 1564. Planar member 1574, arcuate member 1575 and terminal lip 1576 display respective exterior surfaces 1577, 1579, 1581 and interior surfaces 1578, 1580, 1582. Terminal lip 1576 displays tip 1583. Viewed cross-sectionally in FIG. 120, lines 1584, 1585 represent sites on interior surfaces 1565, 1580. Plane 1587 extends through point 1585 and is generally perpendicular to surfaces 1578, 1582. Planes 1588, 1589 extend through tip 1583 and line 1584 and are generally parallel to plane 1587. Plane 1590 extends from surface 1578 and plane 1591 extends from surface 1582. Gap 1592 is the distance between planes 1587, 1588; gap 1593 is the distance between planes 1588, 1589; and gap 1594 is the distance between planes 1590, 1591. Plane 1600 extends

from surface 1577. Plane 1601 extends from surface 1573 and is generally perpendicular to plane 1600. Plane 1605 extends tangentially from the tip of flange 1572 and is generally perpendicular to planes 1600, 1601. Gap 1607 is the distance between planes 1587, 1595. Plane 1595 is generally perpendicular to surface 1577 and extends through a center of bore 1568. Plane 1596 extends through the center of bore 1568 and bisects slot 1570. Angle 1597 is formed by the intersection of planes 1595, 1596.

Exemplary transfer hook 1552 is about 4.03" ( $\pm 0.05$ ") in length and about 1.50" ( $\pm 0.05$ ") wide. Flange 1572 and members 1574, 1576 may be respectively about 0.25" ( $\pm 0.05$ ") and 0.325" ( $\pm 0.05$ ") in thickness. Strap retaining member 1564 may be about 0.25" ( $\pm 0.05$ ") thick, but may be thicker proximate planar member 1574. Respective gaps 1592, 1593, 1594, 1586, 1607 may be about 1.00" ( $\pm 0.05$ "), 1.50" ( $\pm 0.05$ "), 0.75" ( $\pm 0.05$ "), 2.75" ( $\pm 0.05$ "), 1.03" ( $\pm 0.05$ "). Bore 1568 may be about 0.42" ( $\pm 0.05$ ") in diameter. Slot 1570 may be about 0.23" ( $\pm 0.05$ ") wide. Angles 1596, 1603 may be about 20° ( $\pm 10^\circ$ ) and 80° ( $\pm 20^\circ$ ), respectively. Both terminal lip 1576 and flange 1572 may be rounded. If so, the edges of terminal lip 1576 may be rounded to a radius of about 0.50" ( $\pm 0.05$ ") and flange 1572 may be rounded to a radius of about 0.80" ( $\pm 0.05$ "). In this embodiment, transfer hook 1552 is made from extruded aluminum.

Webbing 1550 connects to transfer hook 1554 by means of joint connector bolt 1598 and joint connector 1599. Joint connector 1599 disposes within loop 1558. Joint connector 1599 and loop 1558 are placed within bore 1568. Webbing 1550 is extended through slot 1570. To secure the attachment of webbing 1550 to transfer hook 1552, joint connector bolt 1598 is threadably received onto joint connector 1599. Dimensionally, exemplary web 1550 is about 60" in length and about 1.50" in width. However, it should be appreciated that the dimensions of web 1550 may be altered as necessary. Web 1550 may include materials suitable for automobile seat belts.

Hook and web assembly 1310 is installed onto drum assembly 1424 as depicted in FIGS. 117, 118. First loop 1556 is extended through opening 1344. First loop 1556 is then aligned with apertures 1456, 1460 (FIG. 98). Screw 1464 is passed through aperture 1460 and first loop 1556, then threadably received within aperture 1456.

Exemplary base assembly 1312 is depicted in FIG. 99 and broadly includes leg assembly 1602, vertical adjusting means such as actuator assembly 1604, trunk and skirt assembly 1606, handle assembly 1608, and base shield assembly 1610. Leg assembly 1602, in turn, includes two front legs or bumpers 1622 and two rear legs or bumpers 1624 unitarily extending from central portion 1626. A caster 1628 is attached to a lower surface of each bumper 1622, 1624. Central portion 1626 may display a generally planar surface 1630 which is recessed downwardly from bumpers 1622, 1624. Central portion 1626 further defines a plurality of recessed portions 1632, used as discussed below.

Exemplary actuator assembly 1604 is shown in FIGS. 99, 121 and includes actuator 1640, left actuator support 1642, right actuator support 1644, plunger bracket 1646, plunger pivot arm 1648, actuator cable 1650, and foot pedal assembly 1652. Actuator 1640, in turn, includes base member 1660, actuator body 1664, actuator piston 1666, actuator pump piston 1668, and disk 1670. Actuator body 1664 extends generally transversely from generally horizontal base 1660. The portion of actuator body above base 1660 is generally cylindrical. The portion of actuator body 1664



proximate base 1660 houses a hydraulic reservoir and pump. Actuator piston 1666 is slidingly and coaxially disposed within an upper portion of actuator body 1664. Pump piston 1668 extends from base 1660 generally transversely to actuator body 1664. Disk 1670 is fixed to pump piston 1668 a distance away from a terminus of pump piston 1668. Actuator cable 1650 includes a stiff, flexible wire element 1678 slidingly disposed within jacket 1680. Further included are a plurality of fastening devices, such as ferrules 1682.

Exemplary foot pedal assembly 1652 includes pedal bracket 1686, a plurality of pedal levers 1688, pedal pivot bearings 1690, foot pedal 1692, and foot pedal pad 1694. Pedal lever 1688, in turn, includes lever portion 1696, pedal mounting bracket 1698, and bearing mounting bracket 1700. Pedal mounting bracket 1698 is disposed generally transversely to lever portion 1698 at a first end thereof. Bearing mounting bracket 1700 extends generally transversely from a second end of lever portion 1698. Pedal bracket 1686 attaches to a lower surface of central portion 1626. Pedal lever 1688 is disposed within pedal bracket 1686. Each extension of bearing mounting bracket 1700 is disposed within a pedal pivot bearing 1690. Each pedal pivot bearing 1690 is affixed to a lower surface of central portion 1626. Foot pedal 1692, in turn, is affixed to an upper surface of pedal mounting bracket 1698. Foot pedal pad 1694 is then disposed atop an upper surface of foot pedal 1692.

Referring to FIG. 99, exemplary trunk and skirt assembly 1606 includes trunk 1710, two hat sections 1712, skirt plate 1714, and skirt 1716. Trunk 1710, in turn, includes front panel 1720, left side panel 1722, right side panel 1724, and rear panel 1726. Front panel 1720 is a generally planar member. Left side panel 1722 and right side panel 1724 extend generally transversely from lateral edges of front panel 1720 and include a extended portions 1728, 1729. Extended portions 1728, 1729 are generally rectangular in cross-section. Cord pocket 1730 is attached to an exterior surface of extended portion 1728. Rear panel 1726 extends from rear edges of left and right side panels 1722, 1724. Rear panel 1726 includes planar member 1732. Flange 1734 extends outwardly from an upper edge of planar member 1732. Another flange 1736 extends from an exterior surface of planar member 1732. Bracket 1738 extends rearwardly proximate a right edge of flange 1736. In this embodiment, bracket 1738 is disposed generally transverse to planar member 1732. Cutout 1740 is defined in a lower portion of rear panel 1726 in this embodiment. A cutout may also be defined in a corresponding location of front panel 1720.

Each exemplary hat section 1712 includes base member 1744, front vertical member 1746, rear vertical member 1748, and inboard vertical member 1750. Front, rear and inboard vertical members 1746-1750 extend generally transversely from base member 1744 and join base member 1744 at a bend. A peripheral flange 1752 extends generally transversely from an upper edge of each of vertical members 1746-1750. Inboard vertical member 1750 and an adjoining portion of base member 1744 cooperate to define an inwardly curved surface 1754. Generally planar top skirt plate 1714 coextends with a mated pair of hat sections 1712 when trunk and skirt assembly 1608 is assembled.

Skirt 1716 includes front panel 1760, left side panel 1762, right side panel 1764, and rear panel 1766. Panels 1760-1766 are generally planar. Front flange 1768 and rear flange 1770 extend inwardly from top edges of front panel 1760 and rear panel 1766, respectively. Front panel 1760 and rear panel 1766 further and respectively define cutouts 1772, 1774 on lower-most portions thereof. A multiplicity of wear strips 1776 may be attached to exterior surfaces of panels

1760-1766. In this embodiment, a wear strip 1776 is attached to lower portions of front and rear panels 1762, 1766, proximate cutouts 1772, 1774.

Actuator assembly 1604 and trunk and skirt assembly 1606 are assembled in a cooperative relationship as depicted in FIGS. 99, 121. Left and right actuator supports 1642, 1644 are mated to actuator 1640 and then accommodated in one of recessed portions 1632 within central portion 1626. Left and right actuator supports 1642, 1644 are then affixed to central portion 1626 by threading screws into pre-drilled and pre-threaded holes therefor. Plunger pivot arm 1648 is then seated and pivotally affixed to a recessed portion 1632 on an upper surface of central portion 1626. A portion of pump piston 1668, disposed distally to disk 670, is then mounted to an upper portion of plunger bracket 1646 by being disposed through a slot (not shown) defined therein. One end of wire 1678 is extended through an upper slot defined in plunger bracket 1646. One of ferrules 1682 is then affixed to the end of wire 1678. Trunk 1710 is then lowered into place atop central portion 1626. Two hat sections 1712 are mated around actuator piston 1666 and affixed thereto by fastening means, such as a plurality of bolts threadably mated to nuts. Top skirt plate 1714 is then affixed to mated hat sections 1712 by fasteners such as screws or bolts through pre-drilled holes within top skirt plate 1714 and peripheral flanges 1752. Top skirt plate 1714 and attached hat sections 1712 are affixed to lower surfaces of flanges 1768, 1770 by such means as screws or bolts. The unattached end of wire 1768 is attached to pedal lever 1688 proximate pedal mounting bracket 1698 and secured thereto by a ferrule 1682.

As also shown in FIGS. 99, 121, handle assembly 1608 includes a plurality of handle supports 1788 and handle 1790. Respective holes 1792, 1794 are defined in handle supports 1788 and handle 1790. A first end of each handle support 1788 is accommodated in a recessed portion 1632 within central portion 1626 and affixed thereto. The free ends of handle 1790 then telescopically fit over exposed second ends of each handle support 1788. Handle 1790 is then affixed to each handle support 1788 by such means as bolts or pins extending through holes 1788, 1790.

Exemplary base shield assembly 1610 broadly includes front base shield 1800, rear base shield 1802, and battery cover 1804. Front base shield 1800, in turn, includes front panel 1810, left side panel 1812, and right side panel 1814. Left and right side panels 1812, 1814 extend generally perpendicularly from lateral edges of front panel 1810. Left side panel 1812 defines arcuate cutout 1816 proximate a rear edge thereof.

Exemplary rear base shield 1802, in turn, includes rear panel 1822 and left and right panels 1824, 1826. Rear panel 1822 is generally outwardly curved in cross-section. Flange 1834 extends from an upper edge of rear panel 1822. A lower portion of rear panel 1822 defines recessed portion 1836. Recessed portion 1836, in turn, defines cutout 1838 centrally proximate a lower edge thereof. A pair of laterally disposed handle moldings 1840 are formed proximate an upper and each lateral edge of rear panel 1822. Rear panel 1822 defines bracket slot 1842. Bracket slot 1842 is disposed such that bracket 1738 will extend therethrough when rear panel 1822 is in place. Left and right panels 1824, 1826 extend respectively from left and right edges of rear panel 1822. Left panel 1824 defines cutout 1848 proximate a front edge thereof and coordinate with cutout 1816 defined on left side panel 1812. Label 1850 may be affixed to a predetermined portion 1852 of left panel 1824 in this embodiment. Label 1850 may display such indicia as operating and safety instructions.



Recessed edge **1828** extends from upper surfaces of panels **1810–1814** and **1822–1826**. A flange **1830** extends generally perpendicularly from lower edges of panels **1810–1814** and panels **1822–1826**.

Exemplary battery cover **1804** is unitary in this embodiment and includes rear panel **1860** and left and right panels **1862, 1864**. Rear panel **1860** may be envisioned as including left and right lobes **1868, 1870**. Curved surface **1872** presents vertical wall **1873**. Both curved surface **1872** and vertical wall **1873** are defined by lobes **1868, 1870**. In this embodiment, four generally vertical walls **1876** extend downwardly from rear panel **1860** to form pocket **1874** in an upper portion of right lobe **1870**. When battery cover **1804** is in place, plate **1878** is affixed to the bottom of pocket **1874**. Left and right panels **1862, 1864** extend generally perpendicularly from lateral edges of rear panel **1860**. Also when battery cover **1804** is in place, forward edges of left and right panels **1862, 1864** are proximate lateral edges of recessed area **1836**.

Referring to FIGS. **98, 99, 134**, the components of exemplary electrical and switching system **1314** broadly include charger **1902**, battery **1904**, AC sensor **1906**, logic board **1908**, interlock switches **1910**, proximity switches **1912**, remote coil assembly **1914**, remote switch **1916**, hour meter **1918**, and panel **1920**. Charger **1902**, in this embodiment, receives AC current via power cable **1900** and converts the AC current to DC current for charging battery **1904** via power cable **1901**. Charger **1902** is protected by cover **1903**. Input ratings for charger **1902** may include 90–264 VAC, line frequencies of 47–63 Hz, and currents between 0.80 A–0.35 A. Output ratings for charger **1902** may include, an initial charge voltage of 14.7 VDC, an end of charge voltage of 13.80 VDC, a current of 2.0 A, and a switchover current of 160 mA. Battery **1904** receives DC current from charger **1902** to operate the electrical components of transfer caddy **1302**. Battery **1904** is held in place by bracket **1905**. In this embodiment, battery **1904** is a rechargeable sealed lead acid battery with an output rating of 12 V and a nominal capacity of 12 Amp-hours or more. Also in this embodiment, AC sensor **1906** senses whether charger **1902** is plugged into 110 VAC or 220 VAC. This sensing is relayed to logic board **1908**. A pair of interlock switches **1910** are present as indicated in FIGS. **98, 114**. In this embodiment, proximity switches **1910** are affixed to base panel **1324**, proximate left and right end caps **1480, 1482**. Proximity switches **1910** disable electrical and switching system **1314** when either left or right end caps **1480, 1482** are not in place.

As may be seen in FIGS. **115–116, 134**, another pair of proximity switches **1912** are disposed proximate each interlock switch bracket **1334**. Each proximity switch pair **1912** includes a pair of single switches **1926** and pivot **1927**. Each single switch **1926** within switch pair **1912** operates from a separate circuitry. Switches **1926** are actuated by pivot **1927**. Exemplary remote coil assembly **1914** feeds out or retracts cable **1928**.

Referring to FIGS. **100, 101, 134**, remote switch **1916** is in electrical communication with logic board **1908** via cable **1928**, and remote coil assembly **1914**. Remote switch **1916** includes bottom cover **1940**, top cover **1942**, membrane switch **1944**, and button assembly **1946**. A plurality of moldings **1952** and a segmented platform **1954** may be present in bottom cover **1940**. Top cover **1942** includes another plurality of moldings (not shown), each molding generally aligned with a molding **1952** in bottom cover **1940**. Top cover **1942** also defines switch opening **1960**. Switch opening **1960** is defined proximate platform **1954** when top and bottom covers **1940, 1942** are mated. Mem-

brane switch **1944** includes planar member **1964**, conductor **1966** and tab **1968**. Conductor **1966** generally extends from planar member **1964**. Tab **1968** represents a dielectric extension of conductor **1966**.

Button assembly **1946** is unitary in construction in this embodiment, and includes left and right lobes **1972, 1974** and base **1976**. Left and right lobes **1972, 1974** are joined at base **1976** in this embodiment. In practice, membrane switch **1944** is electrically connected to logic board **1908** via cable **1928**. Membrane switch **1944** is then disposed on platform **1954** and button assembly **1946** is disposed atop membrane switch **1944**. Top cover **1942** is then mated to bottom cover **1940** and secured thereto by a plurality of fasteners, such as screws **1978**. Each screw **1978** extends through bore **1953** of molding **1952** and is threadably received within a complimentary molding formed in top cover **1942**.

Another advantageous feature of exemplary transfer caddy **1302** is a switch controlling clutches **1420** after transfer caddy **1302** has effected a transfer, repositioning or rollover. In a first switch position, clutches **1420**, hence drum assemblies **1424**, turn freely or unwind slightly, thereby enabling the operator to more easily disconnect transfer hook **1552** from transfer rod **1306** after a transfer or repositioning. In a second switch position, clutches **1420** are still engaged with slip plates **1422**, thereby preventing drum assemblies **1424** from turning freely and holding the patient in a new rollover position. In the second switch position, drum assemblies are then reversed when the patient has been secured in the new desired position. Such a switch may be present on remote switch **1916** or proximate power switch **1988** on upper surface **1504** of upper panel **1488**.

Referring to FIGS. **96–98, 134**, panel **1920** includes power switch **1988**, on/off light **1990**, and charge light **1992**. Electrical and switching system **1314** is activated or deactivated by toggling power switch **1988**. On/off light **1990** displays a green color when electrical and switching system **1314** is activated in this embodiment. Charge light **1992** displays an amber light when the available charge in battery **1904** is less than  $11.7 \pm 0.1$  VDC. Charge light **1992** displays a blinking amber light when battery **1904** is being charged by charger **1902**.

As seen in FIG. **134**, exemplary logic board **1908** includes terminals **2000–2016**. Terminal **2000** electrically connects logic board **1908** to left clutch **1420** and to one of redundant proximity switches **1926** of a first proximity switch pair **1912**. Terminal **2002** electrically connects logic board **1908** to right clutch **1420** and to one of redundant proximity switches **1926** of a second proximity switch pair **1912**. Terminal **2004** electrically connects logic board **1908** to motor **1410**. Terminal **2006** electrically connects logic board **1908** to charger **1902**, battery **1904**, and AC sensor **1906**. Terminal **2008** electrically connects logic board **1908** to panel **1920**. Terminal **2010** electrically connects logic board **1908** to right interlock switch **1910** and to another redundant proximity switch **1926** of second proximity switch pair **1912**. Terminal **2012** electrically connects logic board **1908** to remote switch **1916**. Terminal **2014** electrically connects logic board **1908** to yet another redundant proximity switch **1926** of first proximity switch pair **1912** and to left interlock switch **1910**. Terminal **2016** electrically connects logic board **1908** to hour meter **1918**.

Logic board **1908** controls and monitors the operation of transfer caddy **1302**. One function of the operation of logic board **1908** is controlling clutches **1420** and motor **1410** when a transfer event is in progress. Another function of logic board **1908** is monitoring the condition of battery



1904. Still another function of logic board 1908 is monitoring charging of battery 1904 by charger 1902. Yet another function of logic board 1908 is monitoring when charger 1902 is connected to an AC receptacle.

Logic board 1908 controls the operation of clutches 1420 in response to an operator pressing left or right lobes 1972, 1974 of remote switch 1916. Logic board 1908 also actuates motor 1410 when either of clutches 1420 is energized. Logic board 1908 discontinues operation of one of clutches 1420 when a corresponding one of switches 1912, 1914 is activated. The deactivated clutch 1410 is locked-out until remote switch 1916 is cycled off and then on to prevent “chattering” of the clutch when an end of travel is reached. “Chattering” occurs when clutch 1420 is turned off and the tension on web 1550 is thereby released, causing web 1550 to disengage flange 1572 from proximity switch 1912. An end of travel condition is reached when flange 1572 of transfer hook 1552 contacts pivot 1927, thereby engaging proximity switch 1912. Logic board 1908 further prevents operation of either of clutches 1420 or motor 1410 when either interlock switch 1910 is engaged. Either of interlock switches 1910 are engaged when an adjacent end cap 1480, 1482 is not in position. Logic board 1908 further prevents operation of either of clutches 1420 or motor 1410 when charger 1902 is connected to an AC receptacle. Logic board 1908 still further activates the event timer contained within hour meter 1918 when a current above 1A originates from motor 1410. A current above 1A arbitrarily indicates that a transfer is being performed.

Logic board 1908 also functions as a battery condition monitor. Logic board 1908 monitors battery voltage and activates yellow indicator light 1992. Logic board 1908 detects a condition wherein the voltage potential of battery 1904 is less than  $11.7 \pm 0.1$  VDC. Upon detecting this condition, logic board 1908 displays yellow light 1992 until battery 1904 is charged to above this level. If logic board 1908 detects a voltage potential below  $11.7 \pm 0.1$  VDC during a transfer event, there is sufficient energy still contained within battery 1904 to complete the transfer. Logic board 1908 monitors the condition of charger 1902. Logic board 1908 detects when current between charger 1902 and battery 1904 exceeds 0.1 Amps. A current exceeding 0.1 Amps is above the “trickle charge level” charger 1902 typically supplies when battery 1904 is in a charged condition. Logic board 1908 activates light 1992 in response to a current between charger 1902 and battery 1904 exceeding 0.1 A. Logic board 1908 further locks out activation of light 1990 until charging is completed.

When charger 1902 is connected to an AC supply, logic board 1908, via AC sensor 1906, detects this condition for a value between 90–250 Vrms (volt-root mean square). When a value between 90–250 Vrms is detected, logic board 1908 locks out further operation of motor 1410 or clutches 1420. Logic board 1908 further activates light 1990, thus indicating that charger 1902 is connected to an AC supply. If charger 1902 is connected to an AC supply and light 1992 is activated, light 1990 will not be activated until the charging process for battery 1904 is complete.

Power switch 1988 controls power to motor 1410 and clutches 1420. When switch 1988 is toggled to an on position, green light 1990 is activated, indicating that a relay has been energized. This relay (not shown) controls power output to motor 1410 and clutches 1420. However, power for the electronics within logic board 1908 is otherwise not controlled by switch 1988. Thus, the condition of battery 1904 may be continuously monitored.

Exemplary electrical and switching system 1314 may be configured so that between about 135 and 150 transfers may

take place before charge light 1992 is illuminated, if battery 1904 is fully charged before initiation of transfers. Moreover, more than between about 200 transfers and 300 transfers may occur before battery 1904 is so drained of voltage that clutches 1420 disengage, thereby stopping the transfer process. More than between about 35 and 45 transfers may be effected between when charge light 1992 illuminates and when clutches 1420 disengage. Of course, these potential numbers of transfers would depend on factors such as the amperage of battery 1904 when fully charged, the weights of patients transferred, coefficients of friction between the transfer sheets, upon which the patients are disposed and the upper surfaces of transfer bridge 1304 and the surfaces from which and to which the patients are being transferred, and temperatures where transfer caddy 1302 is stored and used.

Transfer caddy 1302 may be about 36 inches wide, thereby enabling transfer caddy 1302 to be rolled through most hospital doorways. However, other embodiments of transfer caddy 1302 may be wider than 36 inches, yet be readily transportable through most doorways.

Another embodiment of the transfer caddy of this invention is depicted in FIG. 137 as transfer caddy 2350. Transfer caddy 2350 differs from transfer caddy 1302 in that handle 2354 is mounted on front and rear bumpers. In this embodiment, handle 2354 is mounted on respective left front and rear bumpers 1622 and 1624 in mounts 2356. Handle 2354 may be secured in mounts 2356 by such fasteners as pins, locking cam assemblies or nut-bolt combinations. Transfer caddy 2350 may further include pivotable handle 2360. Handle 2360 pivots up in the direction of arrow 2362 from a recess in left end cap 1480. Handle 2360 may be used singly or in combination with handle 1608 or handle 2354 in transporting and positioning transfer caddy 2350.

Another embodiment to handle 1608 and 2354 is shown in FIG. 138 as handle assembly 2370. Exemplary handle assembly 2370 includes upper section 2372, left lower section 2374, and a right lower section. Left lower section 2374 and the right lower section are joined to upper section 2372 by hinge assemblies 2378. Hinge assemblies 2378 are mounted such that upper section 2372 folds toward head assembly 1308. However, hinge assemblies 2378 may be mounted to enable upper section 2372 to fold away from head assembly 1308 and down as well. Upper section 2372 may be reversibly locked into an upright position by such means as pins and clip-pin combinations.

Transfer caddy 1302 may be proportioned such that webs 1550 are spaced apart about 26 inches on center. While spacings less than about 26 inches may produce satisfactory results, it becomes more important that the patient’s center of mass be centered between webs 1550 as spacing therebetween decreases.

A transfer bridge, positionable between the horizontal surface on which the patient is disposed and the horizontal surface to which the patient will be transferred, is advantageously employed in the invention. Such an exemplary transfer bridge is depicted in FIGS. 108–110 as 1304. Transfer bridge 1304 includes left and right inboard sections 2102, 2104 and left and right outboard sections 2106, 2108. Each section 2102–2108 displays upper surface 2110 and lower surface 2112. Each section 2102–2108 is hingedly connected to one or more adjacent sections by means of bridgespines 2116. Each bridgespine 2116 includes a flexible low-friction material, such as Cordura®, laid proximate upper surface 2110 and a strip of enhanced friction material,



such as Neoprene, placed proximate lower surface **2112**, thereby sandwiching the material of each of sections **2102–2108** therebetween. The layers are then stitched together in a manner known to the art. Inboard sections **2102, 2104** are joined together by bridgeline **2116** and include loops **2114**. Each loop **2114** may be 0.188" diameter elastic (commonly known as bungee) cord. Each loop **2114** may be approximately 1" in length. Each of sections **2102–2108** may include a material such as polypropylene overlaid with Cordova and reinforced Neoprene. The polypropylene may be 0.125" ( $\pm 0.05$ ") in thickness. A series of longitudinally oriented ribs **2118** may also be present on lower surface **2112**. In this embodiment, sections **2102** and **2104** and sections **2106, 2108** are generally mirror images. Each inboard section may extend outwardly approximately 17.25" ( $\pm 0.1$ "). Each outboard section may extend approximately 16.5" ( $\pm 0.1$ "). The depth of each inboard section **2102, 2104** may taper generally from a maximum proximate a central bridgeline **2116**. The maximum depth of sections **2102, 2104** may be approximately 14.0" ( $\pm 0.1$ "). In this embodiment, tapering continues on both the forward and rear edges. Exemplary transfer bridge **1304** reaches a minimum depth of about 6.56" ( $\pm 0.1$ ") proximate each lateral edge of outboard sections **2106, 2108**. Each exemplary inboard section **2102, 2104** has a length of about 17.25" ( $\pm 0.1$ "). Each exemplary outboard section **2106, 2108** extends about 16.5" ( $\pm 0.1$ "). Indicia, such as arrow **2120**, may be present on upper surface **2110**. In this embodiment, arrow **2120** points toward the patient to be transferred. However, other indicia may be present on surfaces **2110, 2112** as well.

Referring to FIGS. **102–107**, exemplary transfer rod **1306** includes first section **2140**, second section **2142**, and cord **2144**. First and second sections **2140, 2142**, respectively, include hollow rods **2146, 2148**. Each rod **2146, 2148** defines a generally coaxial bore **2150**. Bore **2150** is generally oval in cross-section. First section **2140** includes rod covers **2156, 2158**. Second section **2142** includes covers **2160, 2162**. Each section **2140, 2142** also includes several rod caps **2166**. Each rod cap **2166** is generally oval in cross-section and defines opening **2168** therein. Each rod cap **2166** further displays a flat surface **2170** and a rounded surface **2172**. A plurality of lips **2174** generally extend transversely from a midpoint of each flat surface **2170**. Opening **2168** generally conforms to an outer cross-sectional geometry of rods **2146, 2148**. Each transfer rod **1306** may further include a plurality of cord plates **2178**. In this embodiment, cord plate **2178** is generally planar and configures to a cross section of rods **2146, 2148**. Cord plate **2178** may further define a plurality of openings **2180**. A plurality of O-rings **2184** may also be present and, if present, are disposed as described below. In this embodiment, each rod **2146, 2148** is made of material which includes extruded aluminum. Each rod cover is extruded urethane overlaid with a material with a durometer, further enabling rods **2146, 2148** to grip a sheet.

Prior to assembly, a rod cap **2166** is installed in each end of each rod cover **2156–2162**. Installation includes contacting each lip **2174** to an interior surface of each rod cover **2156–2162** until flat surfaces **2170** contact the end of each rod cover **2156–2162**. Rods **2146, 2148** are then forced inside the assembled rod cover-rod cap combinations, for example by a hydraulic press, such that a gap **2188** is assured therebetween. Gap **2188** will accommodate transfer hook **1552** as discussed below. An O-ring **2184** is then inserted onto rod **2146**. Elastic cord **2144** is then installed within bores **2150** of rods **2146, 2148**. Each end of cord **2144** is

passed through each opening **2180** in a cord plate **2178**. A knot is then formed in each free end of cord **2144**, thereby holding cord plates **2178** in place by the resulting tension.

In this embodiment, rods **2146, 2148** are about 27" ( $\pm 0.5$ ") and 20" ( $\pm 0.5$ "), respectively, with a cross-sectional width of 1.5" ( $\pm 0.007$ ") and a cross-sectional height of 0.5" ( $\pm 0.007$ "). Bore **2150** has a cross-sectional height of about 0.25" ( $\pm 0.01$ ") and a cross-sectional width of 0.75" ( $\pm 0.01$ "). Rod covers **2156–2162** are about 17" ( $\pm 0.5$ "), 10.5" ( $\pm 0.5$ "), 14.38" ( $\pm 0.5$ "), and 14.38" ( $\pm 0.5$ "), respectively, with a cross-sectional width of about 2.0" ( $\pm 0.03$ "), and a cross-sectional height of about 1.0" ( $\pm 0.02$ ").

When assembled, a free end of rod **2146** extends from first section **2140**. An inboard portion of rod cover **2160** does not contact rod **2148**. Thus, the free end of rod **2146** slidingly fits within rod cover **2160** and results in an assembled transfer rod **1306** of approximately 66" ( $\pm 1.0$ ") in length. Of course, other lengths for transfer rod **1306** are possible as well. Transfer rod **1306** may, for example, be between about 45 inches and 72 inches long. However, longer transfer rods tend to better distribute the loads generated by patients. Moreover, centering of patient mass becomes less important as transfer rods increase in length.

Assembled transfer rod **1306** is broken down for storage by separating sections **2140, 2142** in the directions indicated by arrows **2192**, then by folding sections **2140, 2142** together in the directions indicated by arrows **2194**.

FIGS. **122–132**, depict exemplary steps in a patient transfer using the lateral patient transfer system of the present invention. A patient is lying on a first support **2304**. Disposed between the patient and first support **2304** is sheet **2306**. The patient is to be transferred to second support **2308**. First support **2304** and second support **2308** display respective upper surfaces **2310, 2312**. An attendant has previously transported second support surface **2308** and transfer caddy **1302** into the room. Second support **2308** has been positioned such that it angles away from first support **2304**, thereby providing working space for the attendant. The attendant has locked wheels present on first support **2304** where possible. The attendant has further withdrawn transfer rod **1306** from pocket **1874** and mated first and second sections **2140, 2142**. Transfer caddy **1302** has been positioned on a side of second support **2308** opposite first support **2304**. Side rails on first and second supports **2304, 2308** have been lowered, if present. Transfer rod **1306** is then placed atop sheet **2306** and centered to align generally with the center of the patient's body, as depicted by line **2314**. Sheet **2306** is untucked and folded over transfer rod **1306**. Transfer rod **1306** is rolled at least once toward the patient. However, transfer rod **1306** may be rolled until transfer rod **1306** and an enwrapped portion of sheet **2306** are as close to the patient as possible. Transfer bridge **1304** is then unfolded and placed under transfer rod **1306**. Transfer bridge **1304** is positioned such that the cambered edge is proximate the patient. Indicia such as arrows will point toward the patient to be transferred in some embodiments of transfer bridge **1304**. Each hook and web assembly **1310** is unrolled from transfer caddy **1302** and placed upon second support **2308**. Hooks **1552** are then emplaced about rods **2146, 2148** and enwrapped sheet **2306** at gaps **2188**. Second support **2308** is then brought into contact with first support **2304** as depicted by arrow **2316** in FIG. **127**. First and second supports, **2304, 2308** are then docked if possible. Also, wheels on second support **2308** are locked if possible. Finally, supports **2304, 2308** may be adjusted such that surface **2312** is approximately 1 inch lower than surface **2310**. Transfer caddy **1302** is then positioned as close to second support **2308** as possible and aligned with the center of the patient.



The vertical height of head assembly **1308** is then adjusted by foot pedal **1692**. Head assembly **1308** may be raised by pumping foot pedal **1692** as shown by arrow **2315**. Head assembly **1308** may be lowered by depressing and holding foot pedal **1692** until head assembly **1308** is at the desired vertical height. The desired vertical height of head assembly **1308** is such that a distance H (FIG. **126**) is formed between webbing **1550** and surface **2312**. Distance H in this example is about 1 inch. A value of about 1 inch for distance H will result in stable contact between transfer caddy **1302** and second support **2308**. As seen in FIG. **113**, head assembly **1308** is raised or lowered as indicated by arrows **2313** by foot pedal **1692**. In this embodiment, head assembly **1308** may be raised a distance **2317** from its lowest position. Exemplary distance **2317** is about 11 inches ( $\pm 2$  inches). Alternately, an electric motor may be used to actuate raising and lowering head assembly **1308**, for example, by powering a hydraulic pump. If an electric motor is employed, foot pedal assembly **1652** would be replaced with an electric switch. Alternately, an electric switch could be mounted proximate switch **1506** on upper panel **1488**.

Returning to FIGS. **122–132**, the attendant then removes remote switch **1916** from remote aperture **1522** and withdraws a desired length of power cable **1928**. Left and right lobes **1972**, **1974** are depressed as needed until the slack in webs **1550** has been taken up and webs **1550** are taut. The transfer event begins when lobes **1972**, **1974** are depressed simultaneously and the patient begins to be moved atop transfer bridge **1304** and toward second support **2308**. The attendant may insure that transfer bridge **1304** is not displaced by holding transfer bridge **1304** until the patient is atop thereof. Once the patient has been transported generally to a center position on second support **2308**, the attendant discontinues depressing left and right lobes **1972**, **1974**. However, if for some reason the patient transfer continues past this point, a safety mechanism provided in transfer caddy **1302** will automatically discontinue the transfer.

As depicted in FIGS. **115**, **116**, transfer hook **1552**, transfer rod **1306**, and an enwrapped portion of sheet **2306** are being retracted toward head assembly **1308**. If the patient transfer is not discontinued by an attendant, flange **1572** will contact and displace pivot **1927**. Pivot **1927** actuates proximity switch **1912**, when displaced and thereby discontinues the transfer.

Once the patient has been transferred to second support **2308**, the transfer event is ended. Transfer hooks **1552** are disconnected from transfer rod **1306** and sheet **2306** is then unwrapped from transfer rod **1306**. Sections **2140**, **2142** of transfer rod **1306** are then separated and returned to their storage position on transfer caddy **1302**. Transfer bridge **1304** is removed, refolded, and returned to its storage position on transfer caddy **1302** as well. Side rails are then raised on second support **2308**, if present. Transfer caddy **1302** may be then rolled away and transported to another desired location.

The beginning and end of a patient transfer event are characterized by an advantageous feature of the present invention. Web **1550** is wound on drum assembly **1424** to effect the transfer. If drum assembly **1424** were directly connected to shaft **1418**, rather than to magnetic clutch assembly **1420**, the transfer would begin and end abruptly. That is, drum assembly **1424** would begin to wind and cease winding at full speed. Thus, an abrupt and potentially uncomfortable beginning and ending of the patient transfer event might occur. However, addition of magnetic clutch assembly **1420** and slip plate **1422** results in a more gradual acceleration and deceleration in the rotation of drum assem-

bly **1424**. Hence, the patient transfer effected by the present invention begins and ends in gradually increasing rates of transfer.

Another embodiment of the invention is depicted in FIG. **135** as exemplary patient transfer system **2330**. Exemplary patient transfer system **2330** is similar to patient transfer system **1330** with the exception that extended bumpers **2334** are present in place of bumpers **1484**. As seen in FIGS. **98** and **135**, bumpers **2334** differ from bumpers **1484** by the presence of extended member **2338**. Extended member **2338** mates to front portions of left and right end caps **1480**, **1482**. Other features of bumper **2334** may be similar to those of bumper **1484**. Another embodiment of bumper **2334** is extendible and retractable within endcaps **1480**, **1482** in the direction of arrow **2340**. Bumpers **2334** may be extended or retracted by such means as a worm gear drive (not shown). Still another embodiment of bumpers **2334** includes a plurality of telescoping sections to comprise member **2338** (not shown). Normally, front bumpers **1622** are disposed beneath a bed so that bumpers **1484** can contact the bed frame. Extended bumpers **2334** are advantageous if front bumpers **1622** cannot be positioned beneath the surface on which the patient is to be transferred, because extended bumper **2334** may nonetheless contact the frame.

Alternate embodiments of transfer caddy **1302** are depicted in FIGS. **139–144**. These embodiments employ measures such as weights to enhance the stability of transfer caddy **1302** during a transfer event. Referring to FIGS. **139–141** transfer caddy **1302** is depicted as including weight **2390** mounted on upper surface **2388** of rear bumper (or leg) **1624**. In this embodiment one or more orifices **2392** extend from upper surfaces **2388** to lower surfaces **2394** of rear bumpers **1624**. Threaded apertures may be formed in weights **2390** to coincide with locations of orifices **2392**. Bolts are then extended through orifices **2392** from lower surfaces **2394** of rear bumpers **1624** and threaded into the threaded apertures in weights **2390**.

Referring to FIGS. **142–144**, weight **2398** includes central portion **2404** and respective front and rear extensions **2400**, **2402**. Weight **2398** is formed to conform to the peripheral contours of leg assembly **1602**. Central portion **2404** conforms to the periphery of central portion **1626** of leg assembly **1602**. Respective front and rear extensions **2400**, **2402** conform to peripheries of respective front and rear bumpers **1622**, **1624**. Orifices may be formed in weight **2398** to coincide with the locations of casters **1628** and to accommodate mounting bolts. In this embodiment, weight **2398** is mounted to the underside of leg assembly **1602** by mounting bolts extending therethrough and threaded into apertures formed in leg assembly **1602**. Casters **1628** may then be mounted through weight **2398** into leg assembly **1602**.

Weights **2390**, **2398** may be used singly or in combination with other weights or stability enhancing means. Moreover, weights such as **2390**, **2398** may be mounted by other mounting means such as glues and clamps. Exemplary weights **2390**, **2398** may include such materials as lead, cast iron, steel and other metal alloys. Furthermore, some or all of the desirable stability enhancing means achieved by exemplary weights **2390**, **2398** may be attained by forming all or part of leg assembly **1602** from the same heavier materials as used to form exemplary weights **2390**, **2398**.

Still other stability enhancing means include extending the length of bumpers **1622**, **1624** of leg assembly **1602**. Leading edges **2410** of front bumpers **1622** and trailing edges of rear bumpers **2412** are about 12.5 inches and 8.8 inches, respectively, from center point **2408** in exemplary



leg assembly **1602**. Increasing the distance between center point **2408** and leading edges **2410** would be more effective than increasing the distance between center point **2408** and trailing edges **2412**.

Referring to FIG. **136**, a pair of sheet gripping devices **2380** are shown. Each gripping device **2380** includes a pair of extended gripping members **2384** and a connecting member **2386**. Gripping member pairs **2384** work together in jaw-like fashion and grip a portion of a transfer sheet in a similar manner to several of the embodiments herein. Connecting member **2386** may include means to mate with another connecting member such as transfer hook **1552**. Alternately, connecting member **2386** may include means to allow web **1550** to attach directly thereto. In this embodiment each pair of gripping devices **2380** may grip a sheet portion of about 12 inches in length and a combined sheet portion of about 24 inches.

Referring to FIGS. **145–150**, one embodiment of a pliable underlayment for patient transfer and repositioning is depicted as transfer sheet **2450**. Transfer sheet **2450** includes mantle **2452**, one or more reinforced edges **2454**, and one or more attaching members **2456**. Reinforced edge **2454** may include a number of embodiments discussed below.

Each attaching member **2456** is attached to, and cooperates with, mantle **2452** to define a pocket **2459**. Each attaching member **2456** in this embodiment is attached to mantle **2452** by stitching **2462**. A plurality of slots **2460** may be formed proximate a lateral edge of each pocket **2459**. Exemplary pockets **2459** are about 22 inches in length and about 2 inches wide.

Transfer bar **2470** is used in conjunction with transfer sheet **2450**. Exemplary transfer bar **2470** includes first and second bar segments **2472**, **2473**. However, other embodiments of transfer bar **2470** may be unitary or one-piece in construction. Transfer bar **2470** defines first and second ends **2474**, **2475** and first and second slots **2476**, **2477**. Exemplary transfer bar **2470** is proportioned, and first and second slots **2476**, **2477** are spaced apart, such that slots **2476**, **2477** are exposed when transfer bar **2470** is disposed in pocket **2459**. In one embodiment slots **2476**, **2477** are spaced apart about 24 inches on center and transfer bar is about one inch wide, one-fourth inch in depth, and  $26\frac{3}{4}$  inches in length. While slots **2476**, **2477** are shown generally centered in first and second bar segments **2472**, **2473**, first and second slots **2476**, **2477** may be offset as well. Offset slots tend to maintain transfer bar **2470** in a flattened position during a patient transfer or pullup, thereby decreasing the likelihood of transfer bar **2470** being bent. Slots **2476**, **2477** are dimensioned to accommodate a transfer or repositioning hook such as hook **2480** or transfer hook **1552**. Slots **2460** are formed proximate pockets **2459** and are also proportioned to accommodate connecting members such as hook **2480** or transfer hook **1552**. Hook **2480**, in this example, may extend through slot **2460** and attach to transfer bar **2470** disposed therein.

Transfer sheet **2450** displays respective first, second, third, and fourth edges **2484**, **2486**, **2488**, **2490**. In FIG. **145**, a plurality of pockets **2459** are depicted extending generally parallel to respective first, third, and fourth edges **2484**, **2488**, **2490**, corresponding to a patient's head and sides. FIG. **146** depicts a plurality of pockets **2459** extending generally parallel to respective third and fourth edges **2488**, **2490**, corresponding to portions of transfer sheet **2450** normally flanking a patient. In FIG. **147** a plurality of pockets **2459** are depicted extending generally parallel to each respective first and second edge **2484**, **2486**. Edges **2484**, **2486**, respectively, correspond to edges proximate a

patient's head and foot. While pockets **2459** are depicted as generally contiguous or adjoining in FIGS. **145–150**, pockets **2459** may be spaced apart as well.

In FIGS. **151–161** other embodiments of the substantially pliable underlayment of this invention are depicted. FIG. **151** depicts transfer sheet **2500**. Transfer sheet **2500** includes mantle **2502**. Mantle **2502**, in turn, includes reinforced edges **2504**, a plurality of generally elliptically-shaped slots **2506**, and respective first and second stitchings **2508**, **2510**. In this embodiment, slots **2506** are defined within reinforced edges **2504**. Slots **2506** are configured to accommodate a connecting device such as transfer hook **1552**. A plurality of respective first and second stitchings **2508**, **2510** is present within mantle **2502**. First stitchings **2508** extend generally obliquely (diagonally) from edges **2504**. Second stitchings **2510** extend generally perpendicularly to first stitchings **2508** and extend generally obliquely to reinforced edges **2504** as well. Other reinforcing means may be present within mantle **2502**, either in addition to stitchings **2508**, **2510** or to the exclusion thereof. These reinforcing means include reinforcing fibers, woven into the material of mantle **2502**. These reinforcing means reduce distortion to transfer sheet **2500** to less than about 10% during a patient transfer, repositioning, or rollover event. These reinforcing means may further reduce distortion to less than about 8%. These reinforcing means may still further reduce distortion to less than about 5%.

Transfer sheet **2520** is depicted in FIG. **152**. Transfer sheet **2520** includes mantle **2522**. Mantle **2522**, in turn, includes reinforced edges **2524** and a plurality of generally elliptically-shaped slots **2526**. Though not depicted, reinforcing means such as stitchings **2508**, **2510** may be present as well. Reinforced edges **2524** are partially formed and bordered by hems **2528**. Slots **2526** are bordered by stitching (not depicted) in this embodiment. Slots **2526** are configured to accommodate a plurality of grasping or connecting members such as transfer hook **1552** to accommodate other grasping members requiring wider sights of attachment.

FIG. **153** depicts another embodiment of the pliable underlayment of this invention as transfer sheet **2540**. Transfer sheet **2540** includes mantle **2542**, reinforcements **2544** and apertures **2546**. In contrast to previous embodiments, reinforcements **2544** surround each aperture **2546**, but do not form a continuous reinforced edge. Reinforcements **2544** cooperate with apertures **2546** to form reinforced, discrete connector points. These connector points function to accommodate gripping mechanisms for patient transfers, repositionings, and rollovers. While not depicted, reinforcing means as discussed above may also be present.

Referring to FIGS. **154**, **155** another embodiment of the pliable underlayment of the present invention is depicted generally as transfer sheet **2560**. Transfer sheet **2560** includes mantle **2562** and a plurality of reinforced portions **2564**. A slot **2566** is defined within each reinforced portion **2564** in this embodiment. Adjacent reinforced portions **2564** cooperate to form reinforced edges **2568**. In this embodiment slots **2566** are configured to accommodate a grasping or connecting member such as transfer hook **1552**. In this invention, any of slots **2506**, **2526**, **2566**, aperture **2546** or any opening formed in a pliable underlayment such as any of the transfer sheets described above, may be bordered by such protective and reinforcing means such as grommets.

Another embodiment of the substantially pliable underlayment of this invention is depicted in FIG. **156** as drawsheet **2600**. Drawsheet **2600** offers the advantages of maintaining its shape during a transfer or repositioning event



when gripped by clamps or connected to connecting members. Drawsheet **2600** offers the additional advantage of including an absorptive means, whereby fluids from a patient disposed thereon are transmitted away from the patient. Thus, the absorptive means help keep the patient dry. Drawsheet **2600** offers the further advantages of being washable in normal laundering facilities and eliminating the expense and waste involved when sanitary pads are used to absorb fluids from a patient.

Drawsheet **2600** includes mantle **2602**. Mantle **2602** may include a plurality of layers. Exemplary mantle **2602**, as depicted in FIG. **157**, includes permeable layer **2606**, absorptive layer **2608**, drawsheet layer **2610** and impermeable layer **2612** and any combination thereof. Permeable layer **2606** overlays absorptive layer **2608**. Permeable layer **2606** may include fabrics which allow liquids to pass through to absorptive layer **2608** and which impart a sensation of comfort to a patient lying thereon. Permeable layer **2606** may include fabrics such as cotton, linen, various polyesters such as nylon and rayon, as well as various blends thereof.

Absorptive layer **2608** includes a substance which will absorb liquids, thereby wicking them away from a patient disposed thereon. Absorptive layer **2608** may also include an anti-microbial substance such as Microban® or Biocryl®. These or other anti-microbial agents (biocides) may be capable of killing BRSA bacteria, such as Staphylococcus aureus. An absorptive acrylic spun-laced fabric disclosed in U.S. Pat. No. 5,350,625, assigned to DuPont and incorporated herein by reference, is one example of a suitable material for absorptive layer **2608**.

Drawsheet layer **2610**, as depicted in FIG. **158**, is designed to impart a resistance to distortion due to forces applied during a transfer, repositioning, or rollover event. Drawsheet **2600** thus includes fabrics designed to minimize the “parabolic” effects otherwise occurring in sheets which fail to resist stretching or distortion. One means of reinforcing drawsheet layer **2610** includes stitchings such as **2508**, **2510** as described above. Materials used in drawsheet layer **2610** may include cotton, linen, and polyesters such as nylon, rayon or any blend thereof.

Impermeable layer **2612** is disposed exterior to drawsheet layer **2610**. Impermeable layer **2612** is impermeable to liquids, thus protecting an underlying mattress from fluids originating from a patient disposed thereon. Impermeable layer **2612** may also include materials which reduce friction as drawsheet **2600** is drawn across a bed. Vinyl or silicone applied to a nylon substrate are examples of friction-reducing materials. Impermeable layer **2612** may further include antimicrobial or antibacterial compounds.

As seen in FIG. **156**, absorptive layer **2608** may extend over a central portion of drawsheet **2600**. Absorptive layer **2608** may be disposed on drawsheet **2600** so that absorptive layer **2608** underlies the portion of the patient between the patient’s waistline and thighs. Drawsheet layer **2610** in this embodiment, is about 60 inches wide and 72 inches long. Absorptive layer **2608** is about 33 inches wide and about 33 inches long. As seen from FIG. **157**, absorptive layer **2608** is generally centrally disposed on drawsheet layer **2610**. Permeable layer **2606** may extend to within approximately one foot of beaded edge **2604**. Layers **2606–2612** present a tapering to reduce the density of drawsheet **2600**, thereby reducing the thickness of any seam which may contact a patient disposed thereon. By tapering, it is meant that layers **2606–2612** are dimensioned so that their edges do not coincide. For example, the edges of permeable layer **2606**

are disposed outside the edges of absorptive layer **2608**; the edges of impermeable layer **2612** are disposed outside the edges of permeable layer **2606**; and the edges of drawsheet layer **2610** are disposed outside the edges of impermeable layer **2612**. Tapering has the effect of reducing localized pressure on a patient’s skin which a thick seam might otherwise impart. The reduced pressure on the patient’s skin reduces or eliminates irritation. Methods of bonding layers **2606–2612** to each other include stitching.

Also seen in the cross-section depicted in FIGS. **157**, **159** are enhanced beads (beaded edges) **2604**. Enhanced beads **2604** may be hems which include doubled or rolled materials from drawsheet layer **2610**. Electrically conductive, yet flexible materials may also be included in beads **2604**. One advantage of enhanced bead **2604** is that drawsheet **2600** may be more securely gripped during a transfer or repositioning event.

Also depicted in FIG. **156** are exemplary conductors **2614**, **2616**. Conductors **2614**, **2616** extend generally parallel to each other in a non-contacting fashion within absorptive layer **2608**. Conductors **2614**, **2616** further extend from absorptive layer **2608** to logic board **2618**. When absorptive layer **2608** is dry, the electrical potential between conductors **2614**, **2616** is not expressed. However, when absorptive layer **2608** contacts a sufficient amount of liquids with electrolytes, such as urine or perspiration, current flows between conductors **2614**, **2616**. The current originates in a battery such as a 12-volt battery (not shown). Logic board **2618** thereby detects a closed circuit and may transmit an electromagnetic signal to a receiver (not shown), in response, thus alerting an attendant that drawsheet **2600** should be changed. The electromagnetic signal may also be transmitted via a conductor, which may be present in enhanced bead **2604**.

Absorptive layer **2608**, or other layers **2606**, **2610**, **2612**, may also include sensors **2620**. Sensors **2620** may generally extend from absorptive layer **2608** to logic board **2618**. Sensors **2620** may be designed to monitor such phenomena as the patient’s temperature and heartbeat rate. These and other vital signs may also be transmitted electromagnetically to a receiver for automated monitoring and recording.

An alternative embodiment of permeable layer **2606** changes color when exposed to perspiration or urine due to a change in pH, thereby further alerting attendants that sheet **2600** needs to be changed.

FIG. **159** depicts drawsheet **2630**, another embodiment of the present invention. Drawsheet **2630** includes permeable layer **2606**, absorptive-drawsheet layer **2632**, impermeable layer **2612** and beaded edge **2604**. Layers **2606**, **2632**, and **2612** are bonded together, and cooperate in a tapering fashion as described above, except that the material of **2632** serves the dual functions of layers **2608**, **2610** of drawsheet **2600**.

Referring to FIGS. **160**, **161**, yet another embodiment of the substantially pliable underlayment of the present invention is depicted as transfer or repositioning sheet **2640**. Transfer sheet **2640** includes mantle **2642** and beaded edge **2644**. Material from mantle **2642** is wrapped about substantially flexible member **2646** and hemmed against itself, thereby forming beaded edge **2644**. Beaded edges **2604**, **2644** are desirable for attachment by a connecting member such as several of the clamps discussed herein. Affixing means, such as stitching **2648**, is used to affix the overlapping portions of the material of mantle **2642** proximate beaded edge **2644**. Transfer sheet **2640** may further include reinforcing means as discussed above.



Because numerous modifications may be made to this invention without departing from the spirit thereof, the scope of the invention is not to be limited to the embodiments illustrated and described. Rather, the scope of the invention is to be determined by appended claims and their equivalents.

What is claimed is:

1. A substantially pliable underlayment for transferring, repositioning, or rolling a patient disposed thereon, comprising:

a substantially smooth mantle proportioned to accommodate at least a central portion of the patient's body comprising a top layer including a permeable material, a second layer including an absorptive material, a third layer including an impermeable layer and a bottom layer including a reinforced drawsheet;

an attaching structure operably adjacent the mantle; and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure.

2. The underlayment of claim 1, wherein the mantle comprises fabrics selected from the group consisting of linen, cotton, satin, muslin, flannel, polyester and any combination thereof.

3. The underlayment of claim 1, wherein the absorptive layer has a smaller surface area than a remainder of the mantle and wherein the absorptive layer is disposed on a generally central position on the mantle.

4. The underlayment of claim 3, wherein the absorptive layer is disposed such that a portion of the patient between the patient's waistline and the patient's thighs overlays the absorptive layer.

5. The underlayment of claim 1, wherein the impermeable layer at least partially overlays the drawsheet layer, the absorptive layer at least partially overlays the impermeable layer, and the permeable layer at least partially overlays the absorptive layer.

6. The underlayment of claim 1, wherein tie permeable layer, the absorptive layer, the impermeable layer and the drawsheet layer are tapered adjacent the periphery of the underlayment.

7. The underlayment of claim 1, wherein the absorptive layer further comprises a spun-laced acrylic.

8. The underlayment of claim 1, wherein the absorptive layer further comprises an antimicrobial agent.

9. The underlayment of claim 8, in which the antimicrobial agent is capable of killing BRSA bacteria.

10. The underlayment of claim 1, further comprising a plurality of electrical conductors.

11. The underlayment of claim 10, wherein the electrical conductors are in electrical communication when the absorptive layer absorbs a quantity of liquid.

12. The underlayment of claim 10, further comprising a logic device in electrical communication with the electrical conductors.

13. The underlayment of claim 10, further comprising a sensor for monitoring the patient's vital signs.

14. The underlayment of claim 13, in which the sensor monitors one or more of a patient's vital signs selected from the group consisting of heart rate and temperature.

15. The underlayment of claim 1, wherein the attaching structure includes structures selected from the group consisting of a beaded edge, one or more pockets proportioned to accommodate a transfer rod, a plurality of grommets proximate the underlayment periphery, reinforced border including one or more apertures or slots and any combination thereof.

16. The underlayment of claim 15, the beaded edge including a substantially pliable member enclosed and hemmed by the mantle.

17. The underlayment of claim 15, in which the reinforced border includes a composite fiber.

18. The underlayment of claim 1, wherein the attaching structure includes an attaching member attached to the mantle in a manner in which the attaching member and the mantle cooperate to admit a transfer bar therebetween.

19. The underlayment of claim 18, in which the attaching member is substantially pliable.

20. The underlayment of claim 18, in which the attaching member is disposed adjacent a lateral edge of the mantle.

21. The underlayment of claim 18, in which an attaching member is disposed adjacent each lateral edge of the mantle.

22. The underlayment of claim 18, in which a slot is present in the attaching member and accommodates a connecting member of a patient transfer and positioning system.

23. The underlayment of claim 22, wherein the connecting member is a transfer hook.

24. The underlayment of claim 18, wherein the transfer bar includes a first slot position approximately on a first end of the transfer bar and a second slot located on a second end of the transfer bar.

25. The underlayment of claim 24, wherein the first and second slots of the transfer bar are offset from center on first and second ends, respectively.

26. The underlayment of claim 18, wherein the transfer bar comprises a flexible material.

27. The underlayment of claim 1, in which a distortion less than about 10% occurs when a patient is transferred or repositioned.

28. The underlayment of claim 27, in which a distortion less than about 8% occurs when a patient is transferred or repositioned.

29. The underlayment of claim 28, in which a distortion less than about 5% occurs when a patient is transferred or repositioned.

30. The underlayment of claim 1, wherein the reinforcing structure further includes a multiplicity of first stitchings extending generally obliquely from each edge of the underlayment.

31. The underlayment of claim 30, in which the first stitchings are generally parallel.

32. The underlayment of claim 30, wherein the reinforcing structure further comprises a multiplicity of second stitchings extending generally obliquely from each edge of the underlayment and further extending generally transversely to the first stitchings.

33. The underlayment of claim 32, in which the second stitchings are generally parallel.

34. The underlayment of claim 30, wherein the reinforcing structure further comprises a multiplicity of reinforcing fibers.

35. The underlayment of claim 32, wherein the reinforcing structure further comprises multiple reinforcing fibers.

36. The underlayment of claim 1, wherein the reinforcing structure comprises a multiplicity of reinforcing fibers.

37. The underlayment of claim 36, in which the reinforcing fibers extend generally obliquely from each edge of the underlayment.

38. The underlayment of claim 1, wherein the drawsheet is approximately 60 inches wide and 72 inches long.

39. The underlayment of claim 1, wherein the attaching structure includes one or more sets of two or more pockets, said pockets of each set are positioned parallel to each other and said one or more sets are positioned along one or more edges of the mantle.



## 55

**40.** The underlayment of claim **39**, wherein each pocket is adapted to receive a transfer bar.

**41.** A method of transferring or repositioning a patient disposed on a substantially pliable underlayment, the method comprising the steps of:

providing the substantially pliable underlayment, the underlayment comprising a substantially smooth and pliable mantle having a top layer including a permeable material, a second layer including an absorptive material, a third layer including an impermeable layer and a bottom layer including a reinforced drawsheet; an attaching structure operably adjacent the mantle; and a reinforcing structure for imparting a resistance to distortion of the mantle in response to a force exerted on the attaching structure;

attaching a connecting member to the attaching structure; and

exerting the force on the connecting member, the force being sufficient to displace the patient.

**42.** The method of claim **41**, in which the attaching structure includes a beaded edge and in which the connecting member is attached to the beaded edge.

**43.** The method of claim **41**, in which the attaching structure includes an attaching member cooperating with the mantle to form a pocket accommodating a transfer bar and

## 56

in which a plurality of connecting members are attached to the transfer bar.

**44.** The method of claim **43**, in which the transfer bar defines a plurality of slots and in which the connecting members are accommodated by the slots.

**45.** The method of claim **43**, in which a plurality of slits are defined in the pocket and in which each connecting member is at least partially disposed in one of the slits when connected to the transfer bar.

**46.** The method of claim **43**, in which the attaching structure includes a reinforced portion of the mantle defining a plurality of openings and in which the connecting structure connects to at least one of the openings.

**47.** The method of claim **41**, in which the connecting member is a clamp and the clamp is attached to the attaching structure.

**48.** The method of claim **41**, in which the attaching structure defines a plurality of openings and in which the connecting member is plurality of hooks attached to the openings.

**49.** The method of claim **41**, in which the force is exerted by a plurality of pliable members attached to the connecting members and being wound by a transfer caddy.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 6,341,393 B1  
DATED : January 29, 2002  
INVENTOR(S) : Thomas W. Votel

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 54,

Line 2, please delete the word "including" and insert in its place -- includes --.

Column 56,

Line 19, after the word "is" please insert -- a --.

Signed and Sealed this

Twenty-seventh Day of August, 2002

*Attest:*



*Attesting Officer*

JAMES E. ROGAN  
*Director of the United States Patent and Trademark Office*